Program Name : **Mechanical and Civil Engineering Program Group**
Program Code : AE/CE/FG/ME/PT/PG
Semester : **Second**
Course Title : **Applied Science (Physics & Chemistry)**
Course Code : **22202**

1. RATIONALE

Diploma engineers have to deal with various materials and machines. The study of concepts and principles of science like elasticity, viscosity, surface tension, motion, thermo couples, photo-sensors, LASERs, X-Rays, metals, alloys, cement, lime, refractory materials water treatment and analysis, fuel and combustion will help the student to select and use relevant materials and methods which will be economical and eco-friendly.

2. COMPETENCY

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

- **Solve broad-based engineering problems using principles of advanced physics and chemistry.**

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. Select relevant material in industry by analyzing its physical properties.
b. Apply laws of motion in various applications.
c. Use LASERs, X-Rays and photo electric sensors.
d. Select the relevant metallurgical process related to industrial applications.
e. Use relevant water treatment process to solve industrial problems.
f. Use relevant fuel in relevant 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	-	4	8	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, PrCs, 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.

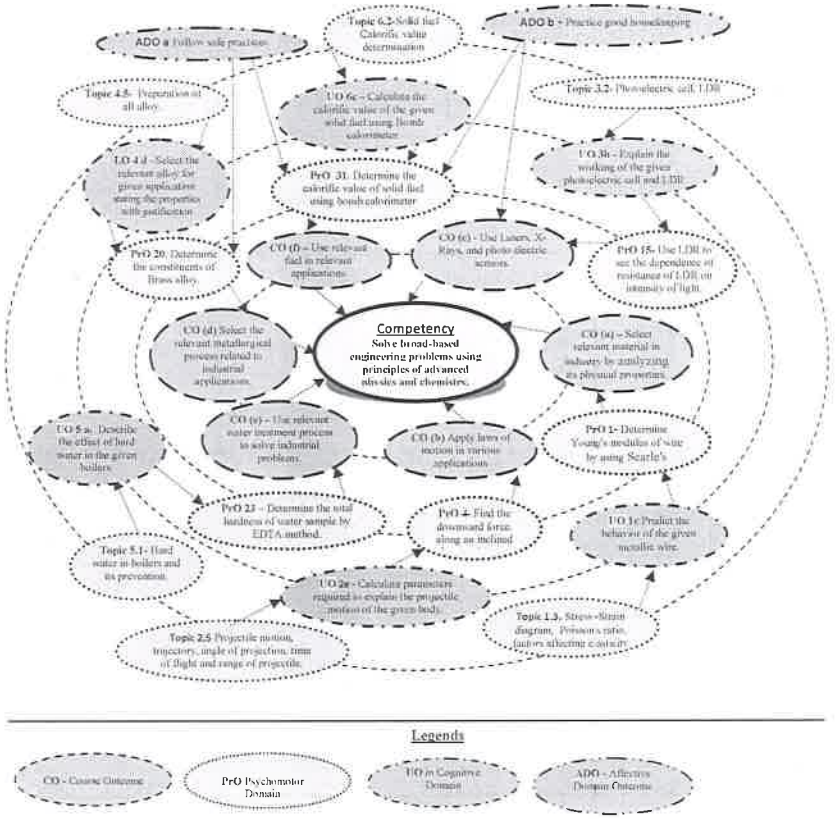

Figure 1 - Course Map

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	Use Searle's method to determine the Young's modulus of given	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	wire		
2	Apply Archimedes' principle to determine the buoyancy force on a solid immersed in liquid.	I	02
3	Determine the coefficient of viscosity of given liquid by Stoke's method.	I	02
4	Find the downward force, along an inclined plane, acting on a roller due to gravity and its relationship with the angle of inclination.	I	02
5	Predict the range of the projectile from the initial launch speed and angle.	II	02*
6	i) Find the dependence of the stopping potential on the frequency of light source in photo electric effect experiment. ii) Find the dependence of the stopping potential on the intensity of light source in photo electric effect experiment.	III	02
7	Determine the I-V characteristics of photoelectric cell and LDR.	III	02*
8	Determine the divergence of laser beam.	III	02
	Chemistry		
9	Standardization of $KMnO_4$ solution using standard oxalic acid and Determine the percentage of iron present in given Hematite ore by $KMnO_4$ solution.	IV	02*
10	Determine the percentage of copper in given copper ore .	IV	02
11	Determine total hardness, temporary hardness and permanent hardness of water sample by EDTA method.	V	02*
12	Determine the alkalinity of given water sample.	V	02
13	Determine the turbidity of given water sample by Nephelometric method.	V	02
14	Determine the moisture and ash content in given coal sample using proximate analysis.	VI	02*
15	Determine the calorific value of given solid fuel using Bomb calorimeter.	VI	02
16	Determine the percentage of Sulphur in given coal sample by ultimate analysis.(Gravimetric analysis)	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

S. No.	Performance Indicators	Weightage in %
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 administrators.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Searle's apparatus(with slotted mass of 0.5 kg each)	1
2	Liquid container	2
3	Solid body (different size and materials)	3,4
4	Stoke's apparatus (glass tube, viscous liquid, spherical balls of varying sizes)	3
5	Stop watch	4,5
6	Photo transducer	4
7	Timer	4
8	Projectile motion detector	5
9	Photo electric effect apparatus	6
10	Experimental setup for characteristics of photoelectric cell	7
11	Experimental setup for characteristics of LDR	7
12	Laser Source (He Ne, diode laser)	8
13	Electronic balance, with the scale range of 0.001g to 500g, pan size 100 mm; response time 3-5 sec.; power requirement 90-250 V, 10 watt.	All
18	Electric oven inner size 18''x18''x18''; temperature range 100 to 250^0 C with the capacity of 40 lt.	14,16
19	Bomb calorimeter	15

S. No.	Equipment Name with Broad Specifications	Exp. No.
20	Muffle furnace, Temperature up to 900^{0}C,digital temperature controller with an accuracy of +/- 3^{0}C	14,16
21	Nephelometer ; Auto-ranging from 20-200 NTU,+/- 2% of reading plus 0.1 NTU, power 220 Volts +/- 10% AC 50 Hz	13

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop LOs in cognitive domain for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Physics	
Unit – I Properties of matter and Non-Destructive Testing	1a. Explain concept of elasticity and plasticity for the given material. 1b. Establish relation between given types of modulii of elasticity. 1c. Predict the behavior of the given metallic wire.	1.1 Deforming Force and Restoring Force, Elasticity, Plasticity, Rigidity 1.2 Stress and Strain and their types, Elastic limit and Hooke's law, types of moduli of elasticity 1.3 Stress -Strain diagram, Poisson's ratio, factors affecting elasticity
	1d. Explain pressure-depth relation for the given law. 1e. Explain Newton's law of viscosity for the given liquid. 1f. Explain Stokes' law for the free fall of the body through the given viscous medium.	1.4 Fluid friction, pressure, pressure- depth relation, Pascal's law, Archimedes' principle 1.5 Viscosity, velocity gradient, Newton's law of viscosity. 1.6 Free fall of spherical body through viscous medium and Stokes' law, derivation of coefficient of viscosity 'η' by Stokes' method, effect of temperature and adulteration on viscosity of liquids.
	1g. Describe the salient features of the given NDT method.	1.7 Non-destructive testing (NDT),Various NDT methods used, Criteria for the selection of NDT method, merits and demerits of NDT
Unit– II Types of Motion	2a. Explain the equations of motion for the given body moving in the given type of path. 2b. Calculate the angular velocity of the given body. 2c. Explain the relevant Newton's laws of motion for the given moving object. 2d. Calculate the work/power/ energy for the given situation. 2e. Calculate the given	2.1 Displacement, velocity, acceleration and retardation, equations of motion, equations of motion under gravity. 2.2 Angular displacement, angular velocity, angular acceleration, three equations of angular motion 2.3 Momentum, impulse, impulsive force, Newton's laws of motion and their Applications 2.4 Work, power and energy: potential energy, kinetic energy, work -energy principle.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	parameters for the given projectile in motion.	2.5 Projectile motion, trajectory, angle of projection, time of flight and range of projectile with formulae.
Unit– III Photoelectricity, X-Rays and LASERs	3a. Explain the concept of the given parameters of the given material. 3b. Explain the working of the given photoelectric device.	3.1 Planck's hypothesis, properties of photons, Photo electric effect: threshold frequency, threshold 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 of the given material with properties and applications.	3.3 Production of X-rays by modern Coolidge tube, properties and applications.
	3d. Differentiate between LASER and given colour of light 3e. Explain the given terms with examples.	3.4 Laser: properties, absorption, spontaneous and stimulated emission, applications of Laser 3.5 Population inversion, active medium, optical pumping, three energy level system, He-Ne Laser.
	Chemistry	
Unit-IV Metals, alloys, Cement, and Refractory materials	4a. Describe construction and working of the given type of furnace. 4b. Describe the extraction process of the given ore with chemical reaction. 4c. Explain purposes and preparation methods of making the given alloy. 4d. Select the relevant alloy for the given application stating the properties with justification. 4e. Describe the constituents, hardening and setting process of the given type of cement. 4f. Select the relevant refractory for given application stating the properties with justification.	4.1 Metallurgy: Mineral, ore, gangue, flux, slag. 4.2 Types of furnace: Muffle furnace, Blast furnace. 4.3 Extraction processes of Haematite, copper pyrite ores: Crushing, concentration, reduction, refining. 4.4 Properties of iron and copper: Hardness, tensile strength, toughness, malleability, ductility, refractoriness, fatigue resistance, specific gravity, specific heat, brazing, castability, stiffness. 4.5 Preparation of alloys (Fusion and compression method). 4.6 Ferrous alloys: Low carbon, medium carbon, high carbon steels. 4.7 Non-ferrous alloy: Brass, Bronze, Duralumin, Tinman Solder, Woods metal. 4.8 Cement: Types; Biocement and Portland cement; constituents, setting and hardening, applications 4.9 Lime: classification, constituents, setting and hardening, applications.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		4.10 Refractory material: Types, properties.
Unit –V Water treatment	5a. Describe the given terminologies related to hard water and their effects 5b. Describe the given process for softening of the given water sample. 5c. Describe with sketches the purification of the given type of water. 5d. Describe the given type of of waste water treatment.	5.1 Hardness; Classification 5.2 Hard water in boilers and prevention: Boiler corrosion, caustic embrittlement, priming and foaming, scales and sludges. 5.3 Water softening: lime soda process (hot lime soda and cold lime soda process), zeolite process, ion exchange process (cation exchange and anion exchange). 5.4 Potable water treatment: Sedimentation, coagulation, filtration and sterilization. 5.5 Waste water treatment: sewage treatment, BOD and COD of sewage water; Reverse Osmosis, recycling of waste water.
Unit-VI Fuels and Combustion	6a. Describe salient properties of the given type of fuel. 6b. Explain the given type of analysis of the given type of coal. 6c. Calculate the calorific value of the given solid fuel using Bomb calorimeter. 6d. Describe composition, properties of given gaseous fuel with their applications. 6e. Calculate the mass and volume of air required for complete combustion of the given fuel.	6.1 Fuel: Calorific value and ignition temperature, classification. 6.2 Solid fuels: Coal, Classification and composition , proximate analysis, Ultimate analysis, Bomb calorimeter, Carbonization of coke by Otto Hofmann's oven. 6.3 Liquid fuels: Fractional distillation of crude petroleum, boiling range, composition, properties, Knocking, cracking, octane number and cetane number. 6.4 Gaseous fuels: Biogas, LPG, and CNG. Combustion equation of gaseous fuels, mass and volume of air required for complete combustion.

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'.

9. 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	Properties of matter and NDT	14	03	05	06	14
II	Types of motion	09	02	02	06	10
III	Photoelectricity, X-Ray and LASER.	09	03	04	04	11
	Chemistry					

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
IV	Metals, alloys, cement, refractory materials	12	02	04	06	12
V	Water treatment	10	02	03	06	11
VI	Fuels and combustion.	10	03	04	05	12
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.*

10. 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.

11. 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.

12. 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 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. **Elasticity:** Prepare working model to demonstrate the stress – strain behavior of different wires of different thickness and material.
b. **Viscosity:** Collect 3 to 5 liquids and prepare a working model to differentiate liquids on the basis of viscosity and demonstrate their applications.
c. **Motion:** Prepare model of ball rolling down on inclined plane to demonstrate the conservation of energy and motion of an object in inclined plane.
d. **Photo Sensors**: Prepare simple photo sensor using LDR.
e. **Properties of Laser**: Use Key chain laser to differentiate laser with ordinary light.
f. **Water analysis**: Collect water samples from different water sources and find the characteristics like acidity, conductivity, dissolved solids, suspended particles.
g. **Water treatment:** Collect 3 to 5 water samples to find the dosage of bleaching powder required for its sterilization.
h. **Water analysis:** Prepare model to find the soap foaming capacity of bore water on addition of soda ash.
i. **Fuels:** Prepare chart showing different types of liquid fuels showing their calorific values and uses.
j. **Cement:** Collect different samples of cement and find their initial and final setting time.
k. **Refractory materials**: Prepare chart showing properties of refractory materials.
l. **Metal properties:** Prepare chart showing different industrial application of metal and relate it with required property or properties using internet.
m. **Alloy steel:** Find the effect of alloying elements like Mn, Cr, Ni, W, V, Co on properties of steel. Prepare chart of showing percentage composition, properties and industrial applications of different types of steel based on above alloying elements using internet.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Physics Textbook Part I and Part - 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 I and part II - Class XII	Narlikar, J.V.; Joshi, A. W.; Ghatak A.K. *et al*	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506314
3	Engineering Physics	Bhattacharya, D. K.; Tandon Poonam	Oxford Publishing, New Delhi, ISBN:0199452814
4	Principles of Engineering Physics -I	Md. Nazoor Khan and Simanchala Panigrahi	Cambridge university press; New Delhi, 2016 ISBN : 9781316635643
5	Engineering Physics	Palanisamy, P. K.	SCITECH Publications, Chennai, ISBN: 9788183711012
6	Principles of Physics	Walker, J.; Halliday, D; Resnick, R	Wiley Publications, New Delhi, 10th edition ISBN: 9788126552566
7	Textbook of Engineering Physics	Avadhanulu, M. N.; Kshirsagar, P. G.	S. Chand and Co., New Delhi, 2015 ISBN: 9788121908177
8	Engineering Chemistry	Agarwal, Shikha	Cambridge university press ; New Delhi, 2015 ISBN : 97811074764

S. No.	Title of Book	Author	Publication
9	Engineering Chemistry	Dara, S. S.; Umare S.S.	S.Chand and Co. Publication, New Delhi, 201, ISBN: 8121997658
10	Engineering Chemistry	Jain & Jain	Dhanpat Rai and sons; New Delhi, 2015, ISBN : 9352160002
11	Engineering Chemistry	Vairam, S.	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 9788126543342
10	Chemistry for engineers	Agnihotri, Rajesh	Wiley India Pvt.Ltd. New Delhi, 2014, ISBN: 9788126550784

14. 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.fearofphysics.com
f. www.sciencejoywagon.com/physicszone
g. www.science.howstuffworks.com
h. https://phet.colorado.edu
i. www.chemistryteaching.com
j. www.visionlearning.com
k. www.chem1.com
l. www.onlinelibrary.wiley.com
m. www.rsc.org
n. www.chemcollective.org
o. www.wqa.org
p. www.em-ea.org