Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Mechnical Engineering

Program Code : ME **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters **Duration : 16 Weeks**

Semester : Second **Scheme - I**

S. N.	Course Title		Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
									Theory							Practical					
									Exam Duration in Hrs	ESE		PA		Total		ESE		PA		Total	
					L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Applied Science	Physics	ASM	22202	2	-	4	8	90 Min	70*#	28	15*	00	100	40	25@	10	25	10	50	20	200
		Chemistry			2	-						15*	00			25@	10	25	10	50	20	
2	Applied Mechanics		AME	22203	3	1	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Applied Mathematics		AMP	22206	4	2	-	6	3	70	28	30*	00	100	40	--	--	--	--	--	--	100
4	Engineering Drawing		EDR	22207	3	-	4	7	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
5	Business Communication Using Computers		BCC	22009	-	-	2	2	--	--	--	--	--	--	--	35@^	14	15-	06	50	20	50
6	Mechanical Engineering Workshop		MEW	22010	-	-	4	4	--	--	--	--	--	--	--	50#	20	50-	20	100	40	100
			Total		**14**	**3**	**16**	**33**	--	280	--	120	--	**400**	--	**185**	--	165	--	350	--	750

Student Contact Hours Per Week: **33 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **750**

Abbreviations: ESE End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* 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 LOs required for the attainment of the COs.

- For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **It is mandatory for the candidate to appear for practical (ESE) of both the part of Applied Science (Physics & Chemistry). Candidate remaining absent in exam of any one part, will be considered as absent for the head ESE (PR) of Applied Science.**
- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

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, thermal properties, photo-sensors, LASERs, X-rays, metals, alloys, cement, lime, refractory materials, water treatment and analysis, fuel and combustion will help the students to select and use relevant materials and methods which will be economical and eco-friendly.

2. COMPETENCY

The 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						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
2	-	2	6	1½ Hrs	70	28	15*	00	100	40	25@	10	25	[illegible]	[illegible]	[illegible]	
2	-						15*	00			25@	10	25	[illegible]	[illegible]	[illegible]	

(*): 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 LOs 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.

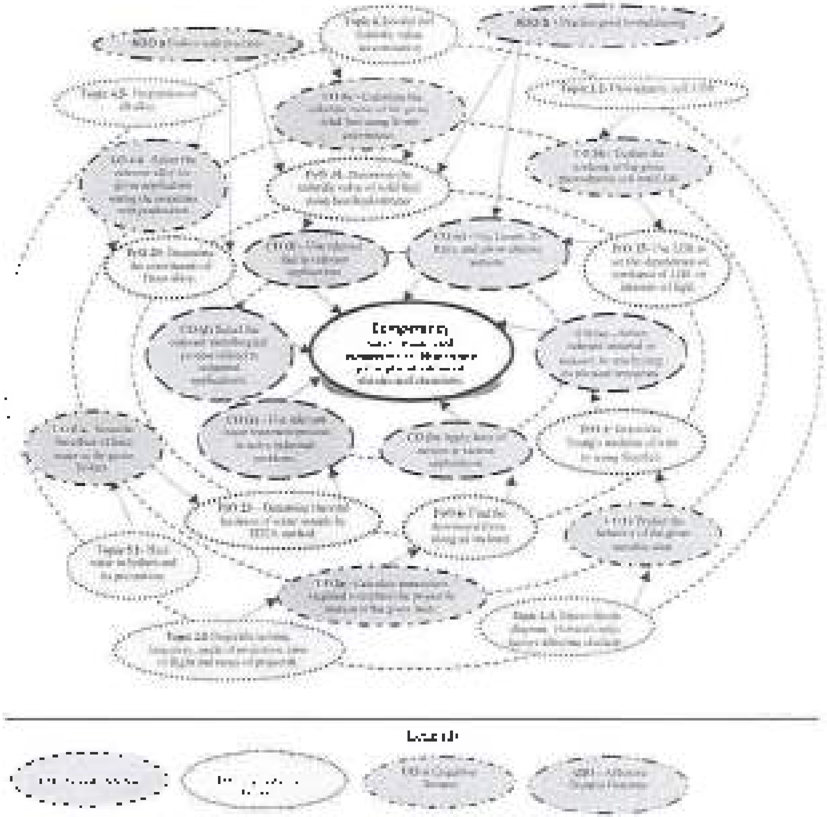


Figure 1 - Course Map

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	site		
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	V	02*
16	Determine the percentage of Sulphur in given coal sample by ultimate analysis (Gravimetric analysis)	VI	02
		Total	32

Note

a. *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.*

b. *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.

5. 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.
	Scale (apparatus) with slotted mass of 0.5 kg each)	1
2	Liquid container	2
3	Solid body (different size and material s)	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° C with the capacity of 40 lt.	14, 16
19	Bomb calorimeter	5

S. No.	Equipment Name with Broad Specifications	Exp. No.
20	Muffle furnace, Temperature up to 900°C digital temperature controller with an accuracy of ± 2°C	14,16
21	Nephelometer – Autoranging from 2 to 200 NTU ± 2% of reading, 0 to 1000 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 UOs 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 moduli 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 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 and energy for the given situation. 2e. Calculate the given parameters for the given projectile in motion.	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. 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 photo electric 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 alloys: Brass, Bronze, Duralumin, Tinman solder, Wood's metal. 4.8 Cement: Types: Slag cement 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 Hoffmann'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	08	02	02	06	10
III	Photoelectricity, X-Ray and LASER.	09	03	04	04	11
	Chemistry					
IV	Metals, alloys, cement, refractory materials	12	02	04	06	12
V	Water treatment	10	02	03	06	11
VI	Fuels and combustion	11	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 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. **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 forming capacity of hard 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 II 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 S. 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, 10[th] 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: 9781107476417
9	Engineering Chemistry	Dara, S. S., Umare, S.S.	S.Chand and Co. Publication, New Delhi, 2011, ISBN: 8121902658
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
12	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://hyperphysics.phy-astr.gsu.edu/hbase/hframe.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.cmseq.org

Program Name	: Mechanical, Civil, Chemical and Fabrication Technology and Erection Engineering Program Group
Program Code	: AE/CE/CH/FG/ME/PT/PG
Semester	: Second
Course Title	: Applied Mechanics
Course Code	: 22203

1. RATIONALE

In day-to-day life we come across different types of structures created for different purposes and functions. While designing the structures, analysis of forces and stresses is an important and prerequisite step. Correct analysis is possible only when one knows the types and effects of forces acting on the structures. This course provides the scope to understand fundamental concepts of laws of mechanics and their applications to different engineering problems. This course is designed to provide basic understanding about the different types of forces, moments and their effects on structural elements, which will help analysing different structural systems.

2. COMPETENCY

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

- Use principles of applied mechanics to solve broad-based engineering related 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. Identify the force systems for given conditions by applying the basics of mechanics.
b. Select the relevant simple lifting machine(s) for given purposes.
c. Determine unknown force(s) of different engineering systems.
d. Check the stability of various force systems.
e. Apply the principles of friction in various conditions for useful purposes.
f. Find the centroid and centre of gravity of various components in engineering systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	1	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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 LOs 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

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.

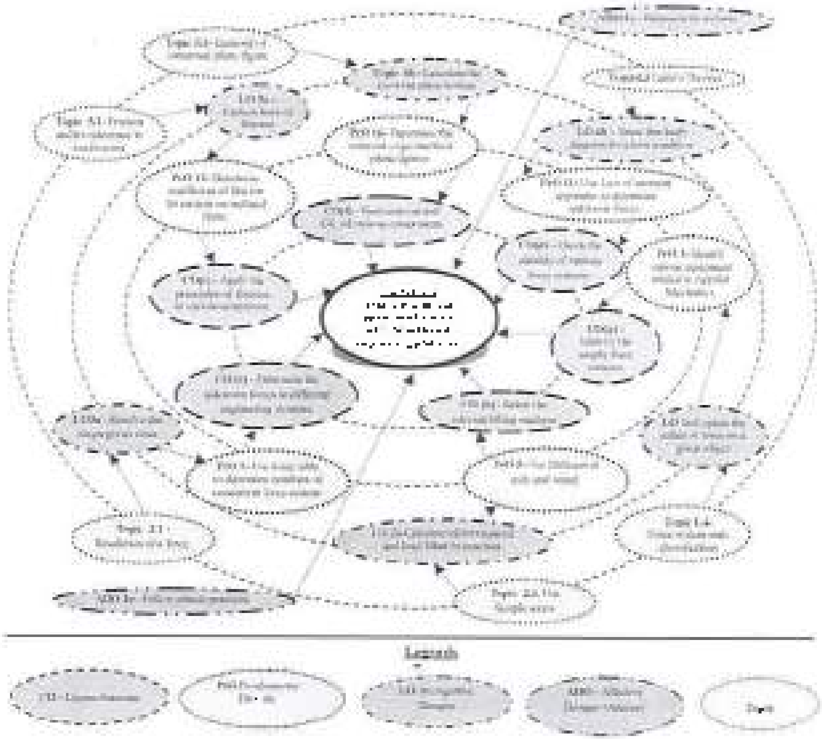


Figure 1 - Course Map

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
1	Identify various equipment related to Applied Mechanics.	I to VI	02
2	Use Differential axle and wheel.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
3	Use Single sheave pulley block.	II	02
4	Use worm and worm wheel	II	02
5	Use simple or double purchase crab	II	02
6	Use Weston's differential or sheerlegs geared pulley block.	II	02
7	Use force table to determine resultant of concurrent force system applying Law of Polygon of forces. (Part-I)	III	02*
8	Use force table to determine resultant of concurrent force system applying Law of Polygon of forces. (Part-II)	III	02*
9	Graphically determine resultant of concurrent force system.	III	02
10	Graphically determine resultant of parallel force system.	III	02
11	Use Law of moment apparatus to determine unknown forces.	IV	02*
12	Apply Lami's theorem to determine unknown force.	IV	02
13	Determine support reactions for simply supported beam.	IV	02
14	Determine coefficient of friction for motion on horizontal plane.	V	02*
15	Determine coefficient of friction for motion on inclined plane.	V	02
16	Determine centroid of geometrical plane figures.	VI	02
	Total		32

Note

- *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. Additional hrs. of minimum 12 or more practical need to be performed in each of which the practicals marked as '*' are compulsory so that the student reaches the 'Precision level' of Dave's 'Psychomotor Domain Taxonomy' as generally expected by the employer.*
- *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	0
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	0
7	Submission of report in time	0
	Total	100

The above PrOs also help in the following social skills/attitudes which are Affective Domain Outcomes. ADOs that are best developed through the laboratory/field based experiences:

a. Follow safety practices
b. Practice good housekeeping
c. Demonstrate working as a leader/a team member
d. Maintain tools and equipment
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 experiments 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 specifications mentioned here will help in procurement in time of experiments as well as in procurement of equipment by administrators.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	2 Differential axle and wheel (coal) mounted unit with the wheel of 40 cm diameter and axles are steps of 20 cm and 10 cm reducing diameter.	2
2	Simple screw Jack (Table mounted) metallic body, screw with a pitch of 5 mm carrying a double flanged turntable of 20 cm diameter.	3
3	Worm and worm wheel (coal) mounted unit with threaded spindle load drum effort wheel with notches + slotted weights, hanger and threads.	4
4	Single Purchase Crab winch (Table mounted heavy cast iron body. The effort wheel - of CI material of 25 cm diameter mounted on a shaft of about 40mm dia. On the same shaft a geared wheel of 15 cm dia.	5
5	Double Purchase Crab winch (Having assembly same as above but with double set of gearing arrangement)	5
6	Weston's Differential pulley block consisting of two pulleys, one bigger and other smaller.	6
7	Weston's Differential worm geared pulley block: Consists of a metallic (preferably steel) cogged wheel of about 20 cm along with a protruded load drum of 10 cm dia to suspend the weights of 10 kg, 20 kg-2 weights and a 50 kg weights)	6
8	Universal Force Table (Consists of a circular 40 cm dia. Aluminium disc, graduated in 360 degrees, with all accessories	7 to 10
9	Law of moments apparatus consisting of a stainless steel graduated beam 12.5 mm square in section, 1m long, provided at centre	9
10	Beam Reaction apparatus: The apparatus is with two circular dial type load	11
11	Friction apparatus for motion along horizontal and inclined plane based on which a sector with graduations and vertical scale is provided. The plane may be clamped at any angle up to 45 degrees part. Two weight boxes each of 5 gm, 10 gm, 2×20 gm, 2×50 gm, 2×100 gm are given.	7
12	Models of geometrical figures	13

8 UNDERPINNING THEORY COMPONENTS

The following topics/subjects should be taught and assessed in order to develop LOs in cognitive domain for achieving the CO's to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Mechanics and force system	1a. Explain concepts of the given terms. 1b. Use the relevant units of various quantities in the given situations. 1c. Explain effects of a force on the given object. 1d. Identify the force system for the given situation.	1.1 Rigid, flexible and deformable bodies, mechanics applied mechanics, statics, dynamics 1.2 Scalar and vector particle, body, rigid body. 1.3 Scalar and vector quantity, Units of measurement (S.I. only). Fundamental units and derived units. 1.4 Force – Unit, representation as a vector and by Bow's notation, characteristics and effects of a force. Principle of transmissibility of force. Force system and its classification.
Unit – II Simple lifting machine	2a. Describe the components of the given lifting machine 2b. Differentiate the working principle of the given two types of simple lifting machines. 2c. Determine velocity ratio, efficiency and law of the given simple lifting machine. 2d. Calculate effort required and load lifted by the given simple lifting machine. 2e. Interpret the graphs after drawing them with the given data. 2f. Select the relevant simple lifting machine required for the given purpose with justification.	2.1 Simple Lifting machine, load, effort, mechanical advantage, applications and advantages. Velocity ratio, efficiency of machines, law of machine. 2.2 Ideal machine, friction in machine, maximum Mechanical advantage and efficiency, reversible and non-reversible machines, condition for reversibility. 2.3 Velocity ratios of Simple axle and wheel, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack, Weston's differential pulley block, geared pulley block. 2.4 Graphs of Load verses Effort, Load verses Effort, Load verses Friction, Load verses V.R, Load verses Efficiency.
Unit– III Resolution and composition	3a. Resolve the given single force. 3b. Calculate the resultant of the given force system analytically. 3c. Determine graphically the resultant of the given force system. 3d. Find the resultant of the given force system using	3.1 Resolution of a force – Orthogonal and Non Orthogonal components of a force, moment of a force, Varignon's Theorem. 3.2 Composition of Forces – Resultant, analytical method of determination of resultant for concurrent non-concurrent and parallel coplanar force systems. Law of triangle, parallelogram and polygon of forces. 3.3 Graphic statics, graphical representation of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	law of triangle and law of parallelogram.	of forces, Space diagram, Force diagram, polar diagram and funicular polygon. Graphical method of determination of resultant for concurrent and parallel coplanar force systems.
Unit– IV Equilibrium	4a. Draw the free body diagram for the given condition. 4b. Determine unknown forces in the given situation using Lami's theorem. 4c. Identify the types of beams required for the given situation. 4d. Determine reactions in the given type of beam analytically and graphically.	4.1 Equilibrium and Equilibrant, free body and free body diagram. Analytical and graphical conditions of equilibrium. 4.2 Equilibrium of force systems under Coplanar. 4.3 Lami's Theorem. 4.4 Types of Beam, supports (simple, hinged or fixed) and their representation, types of load (vertical and inclined point load, U.D.L, uniform, span of beam. 4.5 Beam reaction for cantilever, simply supported beam with or without overhang subjected to combination of point load and U.D.L or Vertical Point load and couple. 4.6 Beam reaction graphically for simply supported beam subjected to vertical loads only.
Unit– V Friction	5a. Determine value of friction and coefficient of friction for the given condition. 5b. Determine the applied force for friction for the given situation. 5c. Determine friction force in the given situation. 5d. Identify the various forces acting on a ladder for the given condition by free body diagram.	5.1 Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, coefficient of friction, angle of friction, angle of repose, relation between coefficient of friction and angle of friction. 5.2 Equilibrium of bodies on level surface subjected to force parallel and inclined to plane. 5.3 Equilibrium of bodies on inclined plane subjected to force parallel to the plane only. 5.4 FBD of ladder in friction.
Unit– VI Centroid and centre of gravity	6a. Determine the centroid of geometrical plane figures and centre of gravity of the given simple solid. 6b. Calculate centroid of the given composite plane figures. 6c. Determine centre of gravity of the given solids. 6d. Determine centre of gravity of the given composite solid.	6.1 Centroid of geometrical plane figures (square, rectangle, triangle, circle, semi-circle, quarter circle). 6.2 Centroid of composite figures composed of not more than three geometrical figures. 6.3 Centre of Gravity of simple solids (C.I. cuboid, cone, cylinder, sphere, hemisphere). 6.4 Centre of Gravity of composite solids composed of not more than two simple solids.

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
I	Mechanics and Force System	04	02	02	02	06
II	Simple Lifting Machines	08	02	04	06	12
III	Resolution and Composition	10	02	04	08	14
IV	Equilibrium	10	02	02	10	14
V	Friction	08	02	04	06	12
VI	Centroid and Centre of Gravity	08	02	02	08	12
	Total	48	12	18	40	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 COs. 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. Collect five different photographs indicating concurrent, parallel, general force system in equilibrium.
b. Prepare a table of types of machine and relevant industrial applications.
c. Collect five different situations where law of moment plays an important role.
d. Prepare models representing various types of supports (hinged, roller and fixed).
e. Illustrate situations wherein friction is essential and not essential.
f. Prepare models in the form of geometrical figures and solids and locate centroid and centre of gravity of them.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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 students 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 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. **Types of Forces**: Prepare chart showing real life examples indicating various types of forces.
b. **Lifting Machine**: Collect photographs of specific simple lifting machine, and relate these machines with the machines being studied, and prepare models of suitable lifting machines using tools in "MECHANO" and "MECHANIX".
c. **Types of supports**: Prepare chart showing actual and corresponding schematic diagram of various types of support.
d. **Beams**: Prepare models of beam subjected to point loads, uniformly distributed loads, simply supported, overhang and cantilever type beam.
e. **Friction**: Prepare chart regarding type of friction in various field conditions and collect data regarding coefficient of friction by referring books. Determine coefficient of friction for three different types of surfaces.
f. **Center of Gravity**: Prepare a chart of situations wherein concept of Centre of Gravity is vital.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Applied Mechanics	Khurmi, R.S.	S.Chand & Co. New Delhi 2014 ISBN: 9788121916431
2	Engineering Mechanics	Ramamrutham, S.	S Chand & Co. New Delhi 2008 ISBN: 9788187433514
3	Foundations and Applications of Applied Mechanics	Ram, H. D.; Chauhan, A. K.	Cambridge University Press Thomson Press India Ltd. New Delhi, 2015, ISBN: 9781107499836
4	Engineering Mechanics: Statics, Vol. I	Meriam, J. L., Kraige, L.G.	Wiley Publication, New Delhi, ISBN: 978-81-265-4396

14. SOFTWARE/LEARNING WEBSITES

a. nptel.iitm.ac.in
b. www.youtube.com for videos regarding machines and applications, friction
c. www.nptel.ac.in
d. www.discoveryforengineers.com

Program Name : Mechanical and Chemical Engineering Program Group

Program Code : AE, CH, FG, ME, PT

Semester : Second

Course Title : Applied Mathematics

Course Code : 22206

1. RATIONALE

Subject of applied mathematics is being introduced in diploma courses to provide mathematical background to the students. This course helps in developing theory and competencies needed for a wide range of engineering applications. In particular the techniques of calculus, differentiation, integration, differential equations and probability distribution for modeling and analysis of a wide range of applications. This course further develops the skills and understanding of mathematical concepts which underpin the investigative tools used in Mechanical engineering.

2. COMPETENCY

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

- **Solve mechanical engineering related problems using the principles of applied mathematics.**

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. Calculate the equation of tangent, maxima, minima, radius of curvature by differentiation.
b. Solve the given problems of integration using suitable methods.
c. Apply the concept of integration to find area and volume.
d. Solve the differential equation of first order and first degree using suitable methods.
e. Utilize basic concepts of probability distribution to solve elementary engineering problems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
4	2	--	6	3	70	28	30*	00	100	40	--	--	--	--	--	--	

(*): Under the theory PA; Out of 30 marks, 10 marks are for micro-project assessment 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 LOs 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.

5. COURSE MAP (with sample COs, Unit Outcomes i.e. UOs 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.

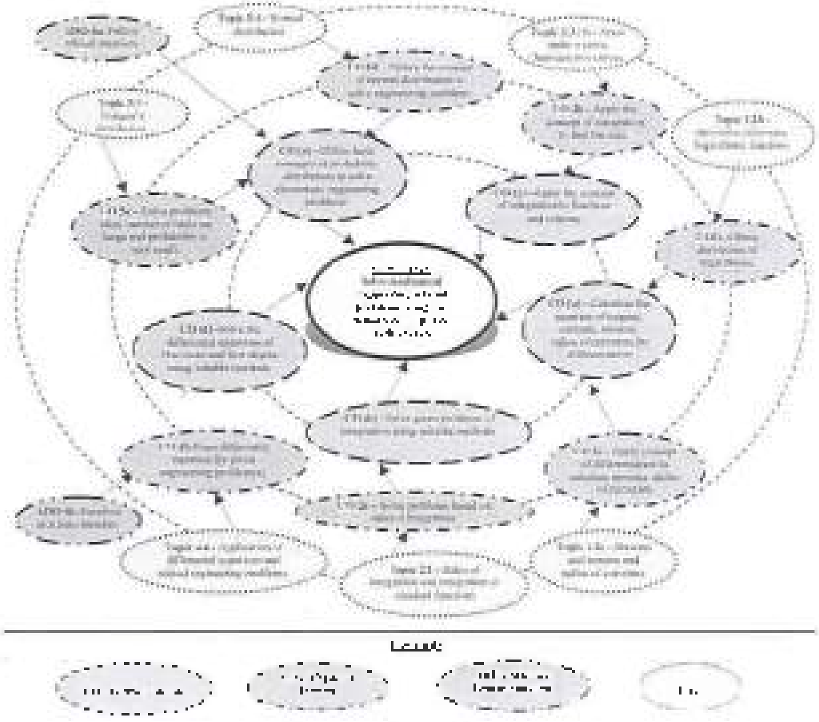


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The tutorials in this section are sub-components of the COs to be developed and assessed in the student to lead to the attainment of the competency.

S. No.	Tutorials	Unit No.	Approx. Hrs. Required
1	Solve problems based on finding value of the function at different points.	I	2
2	Solve problems to find derivatives of implicit function and parametric function.	I	2
3	Solve problems to find derivative of logarithmic and exponential functions.	I	2

S. No.	Tutorials	Unit No.	Approx. Hrs. Required
4	Solve problems based on finding equation of tangent and normal.	I	2
5	Solve problems based on finding maxima, minima of function and radius of curvature at a given point.	I	2
6	Solve the problems based on standard formulae of integration.	II	2
7	Solve problems based on methods of integration, substitution, partial fractions.	II	2
8	Solve problems based on integration by parts.	II	2
9	Solve practice problems based on properties of definite integration.	III	2
10	Solve practice problems based on finding area under curve, area between two curves and volume of revolutions.	III	2
11	Solve the problems based on formation, order and degree of differential equations.	IV	2
12	Develop a model using variable separable method in related engineering problem.	IV	2
13	Develop a model using the concept of linear differential equation to related engineering problem.	IV	2
14	Solve problems based on Binomial Distribution related to engineering problems.	V	2
15	Solve problems based on Poisson Distribution related to engineering problems.	V	2
16	Solve problems based on Normal Distribution related to engineering.	V	2
	Total		32

Note: Tutorials/practical sessions are for guidance only. The remaining tutorial hours are for revision and practice.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

- Not applicable -

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Differential Calculus	1a. Solve the given simple problems based on functions. 1b. Solve the given simple problems based on rules of differentiation. 1c. Obtain the derivatives of logarithmic, exponential functions. 1d. Apply the concept of differentiation to find given equation of tangent and normal. 1e. Apply the concept of differentiation to calculate maxima and minima and radius of curvature of given problem.	1.1 Functions and Limits a) Concept of function and simple examples b) Concept of limits without examples 1.2 Derivatives a) Rules of derivatives such as sum, product, quotient of functions b) Derivative of composite functions (chain Rule), implicit and parametric functions c) Derivatives of inverse, logarithmic and exponential functions 1.3 Applications of derivative : a) Second order derivative without examples b) Equation of tangent and normal c) Maxima and minima d) Radius of curvature
Unit– II Integral Calculus	2a. Solve the given simple problem(s) based on rules of integration. 2b. Obtain the given integral(s) using substitution method. 2c. Integrate given simple functions using the integration by parts. 2d. Evaluate the given simple integral by partial fractions.	2.1 Simple Integration: Rules of integration and integration of standard functions. 2.2 Methods of integration a) Integration by substitution b) Integration by parts c) Integration by partial fractions
Unit– III Applications of Definite Integration	3a. Solve given simple problems based on properties of definite integration. 3b. Apply the concept of definite integration to find the area under the given curve(s). 3c. Utilize the concept of definite integration to find area between given two curves. 3d. Invoke the concept of definite integration to find the volume of revolution of given surface.	3.1 Definite Integration a) Simple examples b) Properties of definite integral (without proof) and simple examples 3.2 Applications of integration : a) Area under the curve b) Area between two curves c) Volume of revolution
Unit–IV First Order First Degree Differential Equations	4a. Find the order and degree of given differential equations. 4b. Form simple differential equations for simple given engineering problems. 4c. Solve given differential equations using the method of variable separable. 4d. Solve the given simple problems based on linear differential equations.	4.1 Concept of differential equation 4.2 Order, degree and formation of differential equation 4.3 Solution of differential equation a. Variable separable form. b. Linear differential equation. 4.4 Application of differential equations and related engineering problems.

Unit – V Probability Distribution	5a. Make use of probability distribution to identify discrete and continuous probability distributions. 5b. Solve given problems based on repeated trials using Binomial distribution. 5c. Solve given problems when number of trials are large and probability is very small. 5d. Utilize the concept of normal distribution to solve related engineering problems.	5.1 Probability distribution: a. Discrete Probability distribution b. Continuous Probability distribution 5.2 Binomial distribution 5.3 Poisson's distribution 5.4 Normal distribution

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
I	Differential calculus	20	04	08	12	24
II	Integral calculus	14	02	06	08	16
III	Applications of Definite Integration.	10	02	02	04	08
IV	First Order First Degree Differential equations	05	02	02	04	08
V	Probability distribution	15	02	05	07	14
Total		64	12	23	35	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 LOs. 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. Identify engineering problems based on real world problems and solve with the use of free tutorials available on the internet.
b. Use graphical software's: EXCEL, DPLOT and GRAPH for related topics.
c. Use MathCad as Mathematical Tools and solve the problems of Calculus.
d. Identify problems based on applications of differential equations and solve these problems.
e. Prepare models to explain different concepts of applied mathematics.
f. Prepare a seminar on any relevant topic based on applications of integration.
g. Prepare a seminar on any relevant topic based on applications of probability distribution to related engineering problems.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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 LOs/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 of LOs 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. Prepare models using the concept of tangent and normal to bending of roads in case of sliding of a vehicle.
b. Prepare models using the concept of radius of curvature to bending of railway track.
c. Prepare charts displaying the area of irregular shapes using the concept of integration.
d. Prepare charts displaying volume of irregular shapes using concept of integration.
e. Prepare models using the concept of differential equations for mixing problem.
f. Prepare models using the concept of differential equations for radioactive decay.
g. Prepare models using the concept of differential equations for population growth.
h. Prepare models using the concept of differential equations for thermal cooling.
i. Prepare a chart of binomial distribution by collection of suitable manufacturing industry base data.
j. Prepare a chart of normal distribution by collection of suitable manufacturing industry base data.
k. Prepare a chart of Poisson distribution by collection of suitable manufacturing industry base data.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Higher Engineering Mathematics	Grewal, B S.	Khanna publications, New Delhi , 2013 ISBN: 8174091955
2	A Text Book of Engineering Mathematics	Dutta, D	New Age Publications, New Delhi, 2006, ISBN-978-81-224-1689-3
3	Advanced Engineering Mathematics	Kreszig, Erwin	Wiley Publications, New Delhi, 20th ISBN:978-81-265-5423-2,
4	Advanced Engineering Mathematics	Das, H.K	S. Chand Publications New Delhi, 2008, ISBN:9788121903455
5	Engineering Mathematics, Volume I (4th edition)	Sastry, S S	PHI Learning, New Delhi, 2007 ISBN-978-81-203-3616-2.
6	Comprehensive Basic Mathematics Volume 2	Veena, G.R.	New Age Publications, New Delhi. 2005 ISBN 978-81-224-1689-8
7	Getting Started with MAT LAB-7	Pratap, Rudra	Oxford University Press. New Delhi, 2009, ISBN 10: 0199731241
8	Engineering Mathematics (3rd edition)	Croft, Anthony	Pearson Education, New Delhi,2010 ISBN 978-81-317-2605-1

14. SOFTWARE/ LEARNING WEBSITES

a www.scilab.org SCI Lab
b www.mathworks.com/products/matlab/ - MATLAB
c. Spreadsheet applications
d www.dpplot.com/ - DPlot
e www.ptmathcad.com/ - MathCAD
f www.wolfram.com/mathematica/ - Mathematica
g http://fossee.in/
h https://www.khanacademy.org/math?gclid=CNq4nabCys4CFdOUaAodBloPzg
i www.easycalculation.com
j www.mech-mapce.com

Program Name : Mechanical Engineering Program Group

Program Code : AE/ME/PT/PG

Semester : Second

Course Title : Engineering Drawing

Course Code : 22207

1. RATIONALE

Engineering drawing is the language of engineers. The concepts of drawing language are used in visualizing the situation, materializing the ideas, conveying the instructions which are used in carrying out engineering jobs. The course aims at developing the ability to draw and read projections of lines, planes, solids and develops imagination and translating skills in drawing orthographic, sectional, missing views and auxiliary views of common engineering components. Knowledge of conventional representation of various joints helps to read and draw various production drawings. This course also aims at building foundation for further courses related to engineering drawing and other allied courses in coming semesters.

2. COMPETENCY

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

- Prepare engineering drawings using prevailing drawing standards and instruments.

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. Draw projections of 2D and 3D standard regular entities.
b. Draw sectional views of objects.
c. Draw orthographic, sectional and missing views.
d. Draw auxiliary views of objects.
e. Use various drawing codes, conventions and symbols as per IS SP46.
f. Draw free hand sketches of given engineering elements.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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 LOs 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*

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.

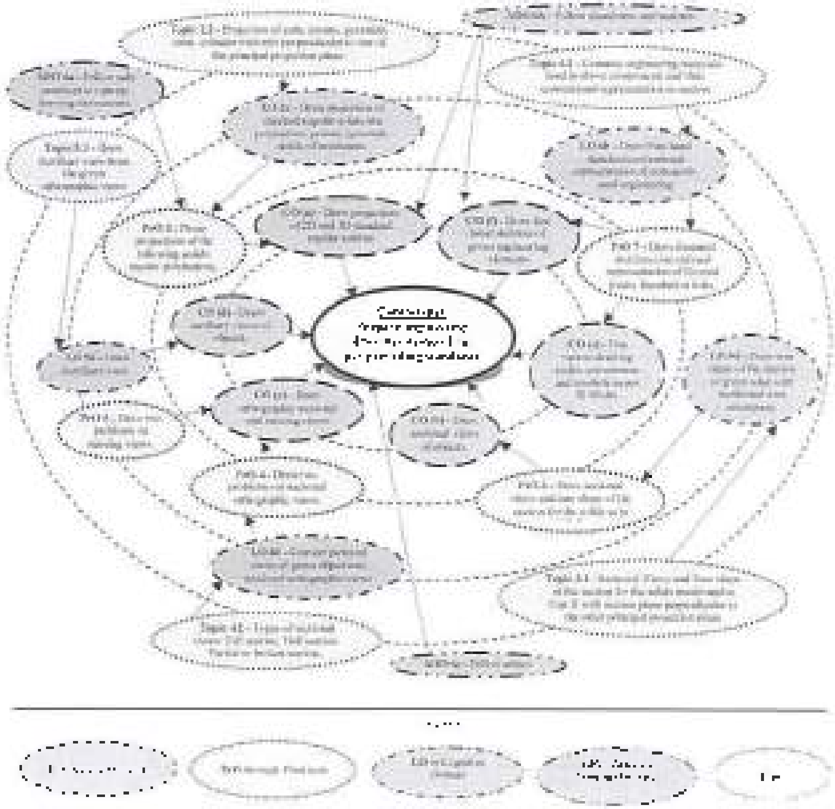


Figure 1 - Course Map

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Draw two problems on projection of straight lines Part I	I	02*
2	Draw two problems on projection of planes Part I	I	02
3	Draw projections of Regular polyhedron Part I	II	02*
4	Draw projections of Regular polyhedron Part II	II	02
5	Draw projections of Regular prisms Part III	II	02
6	Draw projections of Regular pyramids Part IV	II	02
7	Draw projections of Regular solids of revolution Part V	II	02
8	Draw sectional views and true shape of the section for the solids mentioned in S. No 3-6 Part I	III	02*
9	Draw sectional views and true shape of the section for the solids mentioned in S. No 3-6 Part II	III	02
10	Draw sectional views and true shape of the section for the solids mentioned in S. No 3-6 Part III	III	02
11	Draw sectional views and true shape of the section for the solids mentioned in S. No 3-6 Part IV	III	02
12	Draw sectional views and true shape of the section for the solids mentioned in S. No 3-6 Part V	III	02
13	Draw two problems on sectional orthographic views Part I	IV	02*
14	Draw two problems on sectional orthographic views Part II	IV	02
15	Draw two problems on sectional orthographic views Part III	IV	02
16	Draw two problems on sectional orthographic views Part IV	IV	02
17	Draw two problems on missing views Part I	V	02*
18	Draw two problems on missing views Part II	V	02
19	Draw two problems on missing views Part III	V	02
20	Draw two problems on missing views Part IV	V	02
21	Draw two problems on missing views Part V	V	02
22	Draw two problems on missing views Part VI	V	02
23	Draw auxiliary view from the given orthographic views – one problem Part I	V	02
24	Draw auxiliary view from the given orthographic views – one problem Part II	V	02
25	Draw auxiliary view from the given orthographic views – one problem Part III	V	02
26	Draw principal view from the given auxiliary view and other principal view – one problem Part IV	V	02
27	Draw principal view from the given auxiliary view and other principal view – one problem Part V	V	02
28	Draw principal view from the given auxiliary view and other principal view – one problem Part VI	V	02
29	Draw free hand sketches/conventional representation of	VI	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	i. Rivet heads (1 sheet: at least 10 sketches conventional representation) ii. Riveted Joints: Lap Joint – Single and Double Riveted		
30	Draw free hand sketches/conventional representation of: i. Butt Joint – Single Strap, Double Strap. ii. Foundation bolts: Eye and Lewis	VI	02
31	Draw free hand sketches/conventional representation of i. Couplings: Muff, Protected Flange and Flexible Flange ii. Pulleys: Rope and V-Belt	VI	02
32	Draw free hand sketches/conventional representation of i. Welding Joints. ii. Common engineering materials used in practice and their conventional representation in section	VI	02
	Total		64

'*' Compulsory practicals to be performed

Note

i. A suggestive list of practical PrOs is given in the above table, more such practical PrOs can be added to attain the COs and competency.

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	Neatness, Cleanliness on drawing sheet	[illegible]
2	Uniformity in drawing and line work	[illegible]
3	Creating given drawing	40
4	Dimensioning the given drawing and writing text	20
5	Answer to sample questions	10
6	Submission of drawing 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 to operate drawing instruments.
b. Follow cleanliness and neatness.
c. Follow norms and standards.

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
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification required for the Laboratory to effectively conduct of experiments as well as aid to procure equipment by administrators

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Drawing Table with Drawing Board of A1 or D0 imperial size	All
2	Drawing sheet of A2 or half imperial size	All
3	Models of various types of solids	2
4	Models of cut section of various solids	3
5	Models of cut sections of objects	4
6	Models of Mechanical Components	5
7	Models of objects with inclined surfaces	6
8	Specimen/ library of various rivet heads, foundation bolts, welding joints, valves and pipe fittings	7
9	Set of various industrial drawings being used by industries	All
10	Set of drawings sheets mentioned in section A2 could be developed by experienced teachers and made available on the MSBTE portal to be used as reference/standards	All
11	Drawing equipment's and instruments for class room teaching-large size a. T square or drafter (Drafting Machine) b. Set squares (45° and 30°-60°) c. Protractor d. Drawing instrument box (containing set of compasses and dividers)	All
12	Interactive board with LCD overhead projector	All

8. UNDERPINNING THEORY COMPONENTS

The following topics/sub-topics should be taught and assessed in order to develop UOs for cognitive domain for achieving the COs to attain the identified competency

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Projection of straight lines and planes	1a. Classify various positions of lines with respect to projection planes 1b. Draw projection of lines in different positions based on given situation 1c. Classify various types of planes according to orientations 1d. Draw projection of planes with different orientations based on given situation	1.1 Projection of straight lines with following positions a) Parallel to both the planes b) Perpendicular to one plane c) Inclined to one plane and parallel to the other d) Inclined to both the planes 1.2 Traces of a Line 1.3 Projection of Planes with following orientations i. Plane parallel to one principal plane and perpendicular to the other. ii. Plane inclined to one principal plane and perpendicular to the other.
Unit – II Projection of solids	2a. Classify various types of solids	2.1 Types of Solids 2.2 Projection of the following solids:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
of solids	2b. Explain orientation of axis with respect to projection planes 2c. Draw projections of given standard regular solids like polyhedron, prisms, pyramids, solids of revolution	a) Regular Polyhedrat – Tetrahedron Hexahedron (cube) b) Regular prisms and Pyramids Triangular, Square, Pentagonal Hexagonal c) Regular solids of Revolution – Cylinder Cone, Sphere **With Axis:** Perpendicular to one of the principal projection plane. i. Inclined to one of the principal plane and parallel to the other. ii. Parallel to both principal planes
Unit– III Sections of solids	3a. Describe cutting planes and their orientation with respect to given solid and projection planes 3b. Explain significance of sectional view and true shape 3c. Draw sectional view of given solid 3d. Draw true shape of the section of given solid with mentioned axis orientation	3.1 Sections, Views and True shape of the section for the solids mentioned in Unit I with section plane in following positions i. parallel to one of the principal projection plane ii. inclined to one and perpendicular to the other principal projection plane *Note: Position of axis is restricted to the following* Axis parallel to both principal projection planes ii. Axis perpendicular to one and parallel to the other principal projection plane
Unit– IV Sectional orthographic views	4a. Classify various types of sectional views 4b. Explain sectioning and hatching conventions 4c. Convert pictorial views of given object into sectional orthographic views 4d. Interpret the given drawing	4.1 Cutting plane line 4.2 Types of sectional views: Full section, Half section, Part or broken section, Revolved section, Removed section, Offset section, Aligned section 4.3 Sectioning Conventions 4.4 Hatching or section lines 4.5 Conversion of pictorial views into sectional orthographic views
Unit– V Missing and Auxiliary views	5a. Interpret the given views 5b. Draw the missing view from given situation 5c. Interpret given Auxiliary view 5d. Draw Auxiliary view based on given situation	5.1 Draw Missing Lines and views from the given orthographic views 5.2 Auxiliary planes and views 5.3 Draw Auxiliary views from the given orthographic views 5.4 Complete the partial view from the given auxiliary and other principal views
Unit VI	6a. Identify various	6.1 Draw Free hand sketches-conventions

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Free Hand sketches on conventional representation	engineering components and their materials in the given sectional view. 6b. Draw free hand sketches/conventional representation of given engineering components	representation of i. Rivet heads ii. Riveted joints, Lap Joint – Single and Double Riveted, Butt Joint – Single strap, Double Strap iii. Foundation bolts – Eye and Lewis iv. Couplings: Muff, Protected Flange and Flexible Flange v. Pulleys: Rope and V-Belt vi. Welding joints 6.2 Common engineering materials used in above components and their conventional representation in section.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' 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
I	Projection of straight Lines and Planes	10	-	02	08	10
II	Projection of solids	08	-	02	10	12
III	Sections of solids	08	-	02	10	12
IV	Sectional orthographic views	08	-	02	10	12
V	Missing and Auxiliary views	12	02	02	14	18
VI	Free hand conventional representation	04	04	02	-	06
	Total	48	06	14	50	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. Student should maintain a separate A3 size sketch book which will be the part of term work and submit it along with drawing sheets. Following assignments should be drawn in the sketch book.
   i. Minimum 5 problems each on Unit No I to VI.
   ii. Free hand sketches. All types of machine elements mentioned in Unit no-VI.
   iii. Note: Problems on sheet and in the sketch book should be different.
b. Students should collect Production drawings, Layouts from nearby workshops/ industries and try visualize the part from the given views.

c. Each student should explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of sheet for sheet assignment to be explained to each student batch.
d. Each student will assess at least one sheet of other students (Max be a group of six students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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.
f. Show video/animation films to explain sectional orthographic and missing views and other topics.
g. Use charts and enlarged drawing drawing sheets developed by experienced faculty to teach standard symbols and other (industrial) teaching practices.
h. Assign different types of micro projects.
i. Use wooden models to explain the problems.
j. Show the actual parts / models of machine elements mentioned in Unit VI.
k. Use Computer Aided Instructional software for teaching various concepts.

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 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. **Wood/Thermocol Related Jobs:** Students should use the wooden/thermocol models and verify the correctness of views drawn in the problems solved in the sketch book.
b. **Production drawings:** Each student of the batch should collect at least one production drawings from local workshops or industry and list various types of sections used in the drawings.

c. **Production drawings:** Each student should be given 10 problems in which two views of the objects are given with missing lines. Student should identify the missing lines and complete the views.
d. **Thermocol Models:** The teacher will assign one set of orthographic views/auxiliary views and ask the student to develop 3D thermocol models of the same.
e. Students should collect samples / catalogues of the standard mechanical components available in the market.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Engineering Drawing	Bhatt, N.D.	Charotar Publishing House Pvt. Anand, Gujarat Ltd., ISBN No. 978-93-80358-55-0
3	Machine Drawing	Bhatt, N.D., Panchal, V. M.	Charotar Publishing House Pvt. Ltd. Anand, Gujarat, ISBN No. 978-93-80358-69-7
4	Engineering Drawing	Narayana, K.L., Kannaiah, P.	Scitech Publications India Pvt. Ltd. ISBN No. 978-81-8371-422-6
5	Machine Drawing	Singh, Ajeet	Tata McGraw Hill Education, New Delhi ISBN No. 0-07-063992-2
6	Engineering Drawing	Agrawal, Basant, Agrawal, C. M.	Tata McGraw Hill Education, New Delhi ISBN No. 0-07-068863-9

14. SOFTWARE/LEARNING WEBSITES
a. http://www.youtube.com/watch?v=oLYPp2wCYQ
b. http://www.youtube.com/watch?v=SAG-J4oth_Cg&feature=plcp
c. http://www.youtube.com/watch?v=nEENL32rFOU
d. http://www.youtube.com/watch?v=gRVvsxNLFQ
e. http://www.youtube.com/watch?v=_M5ch B6056M
f. http://www.youtube.com/watch?v=UyR0lu5AMu4
g. http://www.youtube.com/watch?v=eix5xhqb91s
h. http://www.youtube.com/watch?v=kWC45irDLRc
i. http://www.youtube.com/watch?v=g_hrQjuaX&feature=related
j. http://www.youtube.com/watch?v=PXgkBadGHEE
k. Engineering Graphics & Drawing v.1.0 from Cognifront

Program Name : All Branches of Diploma in Engineering and Technology.

Program Code : CE/CR/CS/CH/PS/CM/CO/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/IS/MU/EE/EP/EU/IC/IS/AE/ME/PG/PT/AU/FG/DC/TX/TC

Semester : Second

Course Title : Business Communication Using Computers

Course Code : 22009

1. RATIONALE

Communication is the key factor for smooth and efficient functioning of any industry or business activity. Effective business communication is the lifeblood of any organization and is required to maintain quality and progress. The efficacy of business communication skills are essential for engineering professionals for instructing, guiding and motivating subordinates to achieve desired goals at work place. It is very crucial for an entrepreneur to run organization successfully by communicating effectively and skillfully with employees, customers and investors. Thus this course has been designed to enhance the skills to '*Communicate effectively and skillfully at workplace*'.

2. COMPETENCY

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

- Communicate effectively and skillfully at workplace.

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. Communicate effectively by avoiding barriers in various formal and informal situations.
b. Communicate skillfully using non-verbal methods of communication.
c. Give presentations by using audio-visual aids.
d. Write reports using correct guidelines.
e. Compose e-mail and formal business letters.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
--	--	2	2	--	--	--	--	--	--	--	25@	10	25	10	50	20	

(@): For this practical only course, the ESE (25 marks) has two components namely practical marks i.e. the assessment of practical has a weightage of 60% (i.e.15 marks) and micro-project assessment has a weightage of 40% (i.e. 10 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment

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.

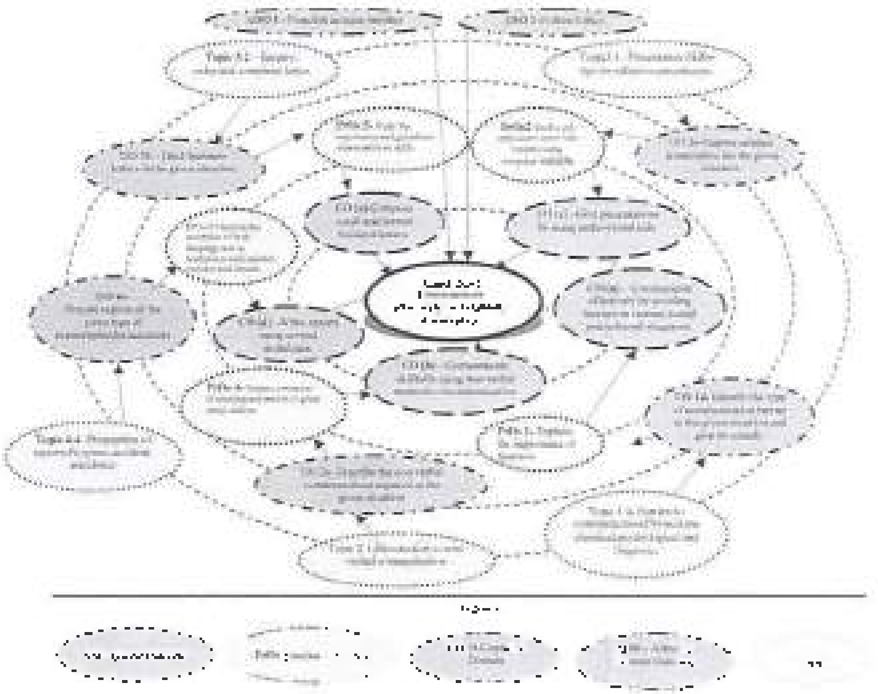


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES (Integrate the theory in the laboratory when conducting practical.)

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
1	Explain the importance of Business communication for an organization using case study.		02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
2	Draft a job application letter with resume using computer.	V	2*
3	Mention the examples of body language use at workplace with suitable pictures and images.	II	2*
4	Prepare minutes of meeting and mail it to given email address.	VI	2
5	Write the importance and guidelines of presentation skills.	III	2*
6	Draft a detailed Progress Report.	IV	2*
7	Organize a debate on types of communication.	I & III	2
8	Summarize an industry report using techniques of summarizing.	IV	2
9	Draft a complaint letter on given topic.	V	2
10	Design Power Point presentation on any technical topic.	III	2*
11	Explain the eight principles of effective communication.	I	2*
12	Explain various non-verbal codes with examples.	II	2
13	Explain the importance of personal appearance stating tips of grooming for a professional.	II	2*
14	Draft a memo on given topic.	V	2
15	Present any Two barriers in communication using case study.	I	2*
16	Present a technical paper using IEEE format.	III	2*
			32

Note

- *A suggestive list of practical LOs is given in the above table, more such practical LOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical LOs/tutorials 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. The size of batch for the practical should not exceed more than 20 students, ideally, for the meaningful attainment of COs and PrOs.*
- *Hence, the 'Process' and 'Product' related skills associated with each LO of the laboratory work/field work are to be assessed according to a suggested sample given below.*

7. MAJOR EQUIPMENTS/ 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	LCD Projector	All
2	Smart Board with networking	All
3	Language lab with internet	All
4	Printer	Wherever Applicable

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)		Topics and Sub-topics
	Writing Skills	Speaking Skills	
Unit – I Introduction to Business Communication	1a. Describe the importance of the business communication in the given situation. 1b. Identify the missing elements in the given communication process. 1c. Identify the types of communication in the given situation. 1d. Identify the type of communication barrier in the given situation and its remedy.	1e. Use different types of verbal and non-verbal communication for the given situation.	1.1 Introduction to Communication: Elements, Importance, Functions. 1.2 Types (meaning and importance) – Verbal (Oral, Written) – Formal, Informal, Vertical, Horizontal and Diagonal communication. 1.3 Principles of effective communication. 1.4 Barriers to communication: Physical, mechanical, psychological and linguistic. 1.5 Business communication: Meaning, characteristics and importance.
Unit– II Non-Verbal Communication	2a. Describe the non-verbal communication required in the given situation. 2b. Describe personal appearance required in the given communicative situation. 2c. Describe the given facial expressions.	2d. Use relevant facial expressions in the given situation. 2e. Answer questions after listening to presentations.	2.1 Introduction to Non-Verbal communication (Meaning and importance). 2.2 Body Language: Aspects of body language: gestures, eye contact, posture, facial expressions, personal appearance (dressing and grooming), vocalics. 2.3 Body language - positive and negative body language.
Unit– III Presentation skills	3a. Prepare seminar presentation for the given situation. 3b. Prepare debate points 'for' and 'against' the given topic. 3c. Prepare the points for computer presentation.	3d. Make seminar presentation. 3e. Participate in debate speaking 'for' or 'against' the given topic. 3f. Make effective	3.1 Presentation skills: tips for effective presentation. 3.2 Guidelines for developing power point presentation. 3.3 Presenting technical papers.

Unit	Unit Outcomes (UOs) (in cognitive domain)		Topics and Sub-topics
	Writing Skills	Speaking Skills	
	for the given topic.	computer presentations.	
Unit – IV Office Drafting	4a. Draft the given notice using the relevant format. 4b. Draft the given memorandum using the relevant format. 4c. Prepare agenda for the given type of meetings. 4d. Prepare minutes of the given type of meetings. 4e. Prepare reports of the given type of events/episodes accidents.	4f. Read the agenda of the given meeting. 4g. Read the report of the given event. 4h. Initiate telephone calls for given situation. 4i. Answer official phone calls for given situation.	4.1 Office drafting: Formats and Guidelines. 4.2 Formulating notices and memoranda. 4.3 Preparation of agenda and writing minutes of meetings. 4.4 Preparation of reports: progress reports, Accident reports, case study. 4.5 Summarizing techniques.
Unit–V Business Correspondence	5a. Respond to given job advertisements by writing your CV/Resume. 5b. Draft business letters in the given situations. 5c. Draft complaint letters for the given situations. 5d. Compose E-mails with relevance for the given situation.		5.1 Business correspondence. 5.2 Enquiry, order and complaint letters. 5.3 E-mails, netiquettes. 5.4 Difference – Curriculum Vitae, Bio-data and Resume. 5.5 Job application and resume writing.

Note: To attain the COs and competency, above listed Learning Outcomes (LOs) need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'. However, such type [illegible] should be covered during practical hours using [illegible].

9. SUGGESTED SPECIFICATION TABLE FOR INTERNAL END SEMESTER EXAMINATION

Unit No.	Unit Title	Distribution of practical Marks			
		R Level	U Level	A Level	Total Marks
I	Introduction to Business Communication	02	02	01	05
II	Non-verbal Communication	02	01	02	05
III	Presentation Skills	02	01	02	05
IV	Office Drafting	02	04	04	10
V	Business Correspondence	02	04	04	10
	Total	10	12	13	35

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 PrOs and COs. 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 GUIDELINES FOR ASSESSMENT TOOL TO CONDUCT INTERNAL END SEMETER EXAM (ESE) :

Weightage (20 Marks) A	Weightage (15 Marks) B	Total
Assessment based on PrOs, practicals conducted during semester Based on computer and written skill. (Minimum four questions each five marks) Sample questions: Eg. I. Draft an email to The manager regarding the shortage of raw material at production department. Note submit the printout of mail. (Computer based) Eg. II Write job application with resume. (written)	Oral examination based on UOs Topics mentioned in syllabus. (Minimum five questions each two marks to be asked) Eg. I Explain the importance of communication in professional life. II. State any four guidelines of presentation skills.	(35 Marks) A+B Duration: 2 hours

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. Collect good articles from newspapers and magazines and read them with correct intonation.
b. Listen to Business news on TV and radio.
c. Watch videos of effective presentations on television and open learning sources for presentation skills and body language.
d. Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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*.

a. Arrange various communication activities using functional grammar.
b. Show video/animation films to develop listening skills and enhance vocabulary.
c. Use real life situations for explanation.
d. Prepare and give oral presentations.
e. Guide micro-projects in groups as well as individually.

12 SUGGESTED TITLES OF MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be 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. Study the personal appearance and grooming of employees visiting sales store, shopping mall in the vicinity.
b. Comparative study of Bio-data, Resume and Curriculum vitae.
c. A detailed study of guidelines required for presentation skills.
d. Summarize technical content using English newspaper, magazines or online resources.
e. Prepare a booklet on aspects of body language in pictorial form.
f. A detailed study of the importance of technical paper of technical paper presentation.
g. Case study on the importance of Business communication in an organization.
h. Report on various formal business activities.
i. Study of oral presentation of famous business leader.
j. Detailed study of business etiquettes observed in organization.
k. Summarize the business article with the help of English newspapers/magazines and other sources.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Effective Communication Skills	M Ashraf Rizvi	Tata McGraw-Hill
2	Communication Skills	Sanjay Kumar and Pushp Lata	Oxford University Press
3	Personality Development and Soft Skills	Barun K. Mitra	Oxford University Press

14. SOFTWARE/LEARNING WEBSITES

a. https://www.britishcouncil.org/english/learn-online
b. http://learnenglish.britishcouncil.org/en/content
c. http://www.talkenglish.com
d. languagelabsystem.com
e. www.wordsworthelt.com
f. www.notesdesk.com
g. http://www.tutorialspoint.com
h. www.studyenglishtoday.com
i. totalcommunicator.com
j. www.speaking-tips.com

Program Name : Mechanical Engineering Program Group

Program Code : AE/ME

Semester : Second

Course Title : Mechanical Engineering Workshop

Course Code : 22016

1. RATIONALE

Diploma mechanical engineer is expected to develop advanced workshop skills, furniture making, fitting, assembly operations, fabrication work, lathe and shaper operations. These operations are widely used in major industries, fabrication and construction industries. Working in workshop develops the skill related to cost effectiveness, team working and safe practices. The technologists have to apply advanced workshop skills in industrial jobs using hand tools, equipment and machineries and accordingly this course has been designed.

2. COMPETENCY

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

- **Perform repairing work of utility jobs in the mechanical engineering workshop.**

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 tools and machinery according to job.
b. Use hand tools in different shops for performing different operations.
c. Operate equipment and machines in various shops.
d. Prepare composite / utility jobs according to drawing.
e. Maintain workshop related tools, instruments and machines.

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
--	--	4	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40

(~): For the practical only courses, the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e. 30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

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.

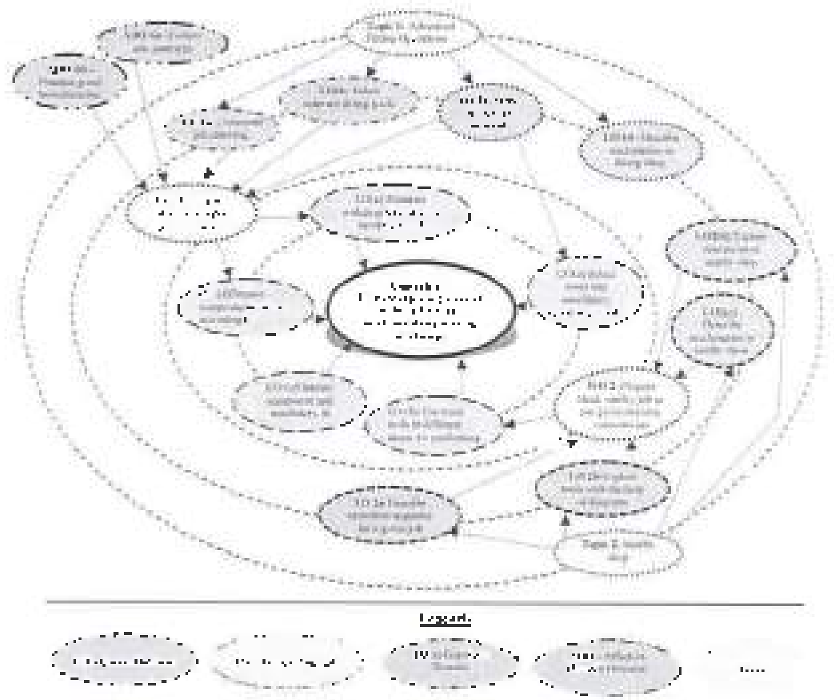


Figure 1 - Course Map

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 Outcome (PrOs)	Unit No.	Approx. Hrs. required
1	Prepare fitting job of male and female assembly type as per given drawing of job with following operations: *Marking operation, Punching operation, Drilling operation, Cutting operation, Filing operation, Fitting operation (male and female assembly), Checking correctness of fit of mating parts.* Part I	I	2*
2	Prepare fitting job of male and female assembly type as per given drawing of job with following operations: *Marking operation, Punching operation, Drilling operation, Cutting operation,*	I	2

S. No.	Practical Outcome (PrOs)	Unit No.	Approx. Hrs. required
	Filing operation, Fitting operation (male and female assembly), Checking correctness of fit of mating parts. Part II		
3	Prepare fitting job (male and female assembly type) as per given drawing or job with following operations: *Marking operation, Punching operation, Drilling operation, Cutting operation, Filing operation, Fitting operation (male and female assembly), Checking correctness of fit of mating parts.* Part III	I	2
4	Prepare fitting job (male and female assembly type) as per given drawing or job with following operations: *Marking operation, Punching operation, Drilling operation, Cutting operation, Filing operation, Fitting operation (male and female assembly), Checking correctness of fit of mating parts.* Part IV	I	2
5	Prepare fitting job (male and female assembly type) as per given drawing or job with following operations: *Marking operation, Punching operation, Drilling operation, Cutting operation, Filing operation, Fitting operation (male and female assembly), Checking correctness of fit of mating parts.* Part V	I	2
6	Prepare fitting job (male and female assembly type) as per given drawing or job with following operations: *Marking operation, Punching operation, Drilling operation, Cutting operation, Filing operation, Fitting operation (male and female assembly), Checking correctness of fit of mating parts.* Part VI	I	2
7	Prepare fitting job (male and female assembly type) as per given drawing or job with following operations: *Marking operation, Punching operation, Drilling operation, Cutting operation, Filing operation, Fitting operation (male and female assembly), Checking correctness of fit of mating parts.* Part VII	I	2
8	Prepare black smithy job (like Hook, peg, flat chisel, bolt head or any hardware items) per given drawing or job with following operations: *Cutting operation, Heating operation, Upsetting operation, Punching operation, Swaging operation, Fullering operation, Bending operation.* Part I	II	2*
9	Prepare black smithy job (like Hook, peg, flat chisel, bolt head or any hardware items) per given drawing or job with following operations: *Cutting operation, Heating operation, Upsetting operation, Punching operation, Swaging operation, Fullering operation, Bending operation.* Part II	II	2
10	Prepare black smithy job (like Hook, peg, flat chisel, bolt head or any hardware items) per given drawing or job with following operations: *Cutting operation, Heating operation, Upsetting operation, Punching operation, Swaging operation, Fullering operation, Bending operation.* Part III	II	2
11	Prepare black smithy job (like Hook, peg, flat chisel, bolt head or any hardware items) per given drawing or job with following operations: *Cutting operation, Heating operation, Upsetting operation, Punching operation, Swaging operation, Fullering operation, Bending operation.* Part IV	II	2
12	Prepare black smithy job (like hook, peg, flat chisel, bolt head or any hardware items) per given drawing or job with following operations: *Cutting operation, Heating operation, Upsetting operation, Punching operation, Swaging operation, Fullering operation, Bending operation.* Part V	II	2
13	Prepare bill of material along with estimated cost according given drawing of jobs such as repairing of classroom furniture, Rack, shelves, metallic doors, motor safe guard, cooler stand with locking device considering the following applicable operations a. Marking operation as per drawing b. Cutting operation as per drawing c. Bending operation as per drawing d. Edge preparation operation as per drawing e. Filing operation as per drawing f. Bending operation as per drawing g. Welding operation as per drawing	III	2*
14	Prepare steel frame / structure of utility job (like stool, benches, tables, drawing desk, window grill, ventilator, door frame or similar jobs involving arc welding joint as per given drawing or job. Part I	II	2
15	Prepare steel frame / structure of utility job (like stool, benches, tables, drawing desk, window grill, ventilator, door frame or similar jobs involving arc welding joint as per given drawing or job. Part II	III	2
16	Prepare steel frame / structure of utility job (like stool, benches, tables, drawing desk, window grill, ventilator, door frame or similar jobs involving arc welding joint as per given drawing or job. Part III	I[illegible]	2
17	Perform fabrication operations to prepare job (wire mesh tray, drawing sheet holder tree guard shoe stand) as per given drawing Part I	III	2*
18	Perform fabrication operations to prepare job (wire mesh tray, drawing sheet holder tree guard shoe stand) as per given drawing Part II	III	2
19	Perform fabrication operations to prepare job (wire mesh tray, drawing sheet holder tree guard shoe stand) as per given drawing Part III	III	2
20	Perform *Cutting operation* operations to prepare small notice board for your workshop institute using soft board / velvet cloth with beading as per given drawing.	IV	2*
21	Perform *Planing operation* operations to prepare small notice board for your workshop institute using soft board / velvet cloth	IV	2

S. No.	Practical Outcome (PrOs)	Unit No.	Approx. Hrs required
	with holding as per given drawing.		
22	Continue experiment No. 20 and perform *Wood turning* operations to prepare small notice board for your workshop institute using soft board, velvet cloth with holding as per given drawing.	IV	2*
23	Continue experiment No. 20 and perform *Joining* operations to prepare small notice board for your workshop institute using soft board, velvet cloth with holding as per given drawing.	IV	2
24	Continue experiment no. 21 and 22 and complete the small notice board for your workshop institute using soft board, velvet cloth with holding as per given drawing by performing *Finishing* operations.	IV	2
25	Continue experiment no. 21 and 22 and complete the small notice board for your workshop institute using soft board, velvet cloth with holding as per given drawing by performing *Varnishing* operations.	IV	2
26	Prepare simple turning job with facing operation as per drawing	V	2*
27	Perform centering operation as per drawing to prepare simple turning job.	V	2
28	Prepare simple turning job with *Plain* turning operation as per drawing.	V	2
29	Prepare simple turning job with *Step* turning operation as per drawing.	V	2
	Total		**58**

Note

a. *A suggestive list of practical PrOs is given in the above table. More such PrOs can be added to attain the COs and competency.*
b. *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.	Prepare experimental set up	20
2.	Prepare job using different operations	30
3.	Follow Safety measures	10
4.	Check the quality of finished job	20
5.	Answers to job related questions	5
6.	Submit journal report on time	5
7.	Follow Housekeeping	5
8.	Attendance and punctuality	5
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. Function as team member.
e. Function as a team leader.
f. Follow ethics.

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. S. No.
1.	**Marking table with scribers:** Black Granite surface flat, non magnetic non glaring, planning accuracy as per IS, size 1000mm x 650mm x 150mm of workshop grade with tungsten carbide scriber 150mm.	1
2.	**Surface plate:** C.I., Sr. fine plate, planed, hand scraped and seasoned. Broad and sharp type ribbing complete with handles for lifting and wooden protective cover, conforming to IS- 2285 - 1965. (1) 450 mm x 450 mm (2) 450 mm x 600 mm.	1
3.	**Measuring Instruments, Marking Instruments, Fitting Hand Tools:** Vee Block, height gauges, vernier calipers, outside and inside calipers, micrometers, bevel protractor, files of different sizes and grades, Hacksaw frames, chisels, Steel rules, try squares, drills, surface gauge, Number punch, dot punch, Divider, Angle plate, screw drivers, spanners etc.	1
4.	**Tap and Die Set:** Both tap and die set complete in box with accessories: 0 - 10 BA, 1/4" to 1" BSF, 1/2" to 3/4" NF, 1/4" to 3/4" NC (number same metric) one set each.	1
5.	**Bench Drilling Machine:** 13 mm capacity motorized Drilling Machine with 0.5 HP / AC / 230 V / 1420 r.p.m. with motor starter switch, 13 mm capacity drilling chuck, V belt with 100 mm swivelling vise.	1
6.	**Bench Grinder:** Double ended bench grinder wheel size 150mm x 20mm x 12.7mm with standard accessories with single phase 0.25 HP motor high speed.	1
7.	**Vice:** Bench Vice 150 mm.	1
8.	**Electrically operated Hand Drilling Machine (pistol Type):** 6mm capacity steel drilling, Power Input 300- 400 W.	1
9.	**Power Hack Saw Machine:** Mechanical type hacksaw machine equipped	1

S. No.	Equipment Name with Broad Specifications	Exp. S.No.
	with coolant pump, vice, length gauge, machine drive belt guard, with capacity to cut round materials up to 175mm and square materials 150mm x 150mm. Blade size 550mm x 25mm and 1 HP (AC 440 V, 50) 1440 RPM Electric motor and starter.	
10	**Pedestal Grinder:** 200mm spindle speed 2600 to 3000 rpm, diameter of wheel 200 mm width 25mm	1
11	**Hand Grinder:** Two speed flexible shaft, 370watts, full load speed 6400 rpm and 665 rpm	
12	**Work Bench:** 1800x1200x750mm	
13	**Hearth with blower:** Centrifugal motorised blower, 1 HP (440V, 50 Hz) with forges, pipe fittings valves. Hearth Size Made of M. S. Sheets 750 mm x 750 mm with water vessel. Length of 2.5 m [illegible] with chimney.	2
14	**Anvil:** Single Horn 150 kg malleable cast iron with stand	2
15	Leg Vice – Standard size	2
16	**Swage Block:** Wrought iron or Malleable cast iron 1450 x 450 x 100 mm size – 250 x 250 x 50 mm	2
17	**Tools and Gauges:** Hammers of different size, Tongs, Chisels, flatteners, fullers, Dies, Punch, Drift etc.	2
18	**Power Hammer:** [illegible] capacity, motorised, equipped with foot lever operated, clutch to control strokes, spring loaded hand lever for adjustment of strokes, [illegible] and the vertical pr[illegible] 5 HP, 440 V, A.C., 3 Ph, 50 Hz, 250 rpm electric motor and starter, having ram weight about 50 kgs. [illegible] strokes per minute 100 to 200, hammers upto diameter 46 mm to 50 mm	2
19	**Bench Grinder:** Double ended bench grinder with 1 HP 3Phase 50 cycles 440 V and one side rough and other side smooth 250mm x 25mm x 15mm grinding wheel complete with wheel guard, tool rest and rotary switch	2
20	**Work Bench With vice:** 1800x1200x750mm	2
21	**Arc welding transformer three phase with standard accessories** – Welding Transformer to provide current from 50 amps to 400 amps for Single operator and 25 amps to 400 amps for two operators at 80 V open current, alternate voltage of 100 V open circuit provision, rotary switch for quick selection of current with following technical specifications conforming to IS 1851 – 1975 Standard Accessories 1. Copper cable single core conforming to IS – 9857 / 1998 – for 600 amps 2. Electrode holder up to 600 amps 3. Hand Screen 4. Earth clamp, tommy bar type 5. Pair of welders Goggles 6. Welders apron 7. Welders glass	3,4,5
22	**Single Phase Air-cooled arc Welding Transformer with Accessories:** Single phase air cooled arc welding transformer, step less variable current regulator for welding current range 40 to 300 amps, conforming to IS – 1851 – 1975	3,4,5
23	**Light Duty Spot Welding Machine:** Portable type spot Welder rating 2.5 KVA, for welding up to 2mm + 2mm M. S. Sheet. Max throat depth 30 cms	3,4,5

S. No.	Equipment Name with Broad Specifications	Exp. S.No.
24	**Band Saw:** Heavy duty vertical band saw machine, size of cast iron table 500 mm x 500 mm, 2 HP (AC 440 V, 50 Hz, 3 phase AC motor with starter). Dia of wheel 450mm, width of wheel 25mm, depth of cut 300mm with standard accessories including dust collector.	6
25	**Band saw and Circular Saw Sharpener:** 150 mm to 1034 mm dia circular saw, 06 mm to 150 mm wide band saw blades, automatic saw sharpening machine, equipped with rocker swivelling arm spindle having pivoting motion for level of blade teeth. Feeds 24 and 30 teeth per minute, provided with 1 HP (AC 440 V, 3 Phase 50 Hz) Electric motor with starter, cast iron pedestal grinding wheel, Motor pulley and V Belt.	5
26	**Chain and Chisel Mortising Machine:** Floor model provided with endless chain cutter & chisel, headstock counter balanced, table has the compound slide for lateral movement by screw adjustment and longitudinal traverse by hand wheel, provided with quick screw clamp, having capacity maximum size of [illegible] max. size of [illegible] mm, depth of [illegible] mm, longitudinal table movement [illegible] mm, lateral movement [illegible] mm, complete with 3ph A.C. 440 v 50 hz electric motor and switch.	6
27	**Vertical Sander:** Vertical sander, sands and polishes flat surfaces, capacity 50 mm, input (full load) 500watts. No load speed 2200 rpm Full load speed [illegible] rpm	6
28	**Heavy Duty Circular Saw:** 1400 watts, 5800rpm. Compact and well balanced. Powerful motor for maximum performance. 100% ball and roller bearings construction. Reversible blade clamp flange	6
29	**Heavy Duty Variable Speed Reciprocating Saw Kit:** 640 watts, 0-2400rpm. Variable speed. Ball and roller bearings construction. Low vibration. Rubber boot. Flush cutting blade position. Externally replaceable brushes. Capacity-164 mm	6
30	**Single Speed Impact Drill:** Powerful motor for maximum performance. Compact and well balanced. Helical gear system. Bearing block for precision gear and spindle alignment. Capacity-13mm	6
31	**Angle Grinder:** Powerful long life motor, spindle lock. Durable and reliable design. Maximum airflow with aerodynamic fan system, compact gear case. External brush access panel. Capacity-100mm	6
32.	Riveting Gun, Hammers, Spanners and torque wrench, Punch, Allen keys	
33	**Centre Lathe (General type):** Max. swing over bed 450 mm, Max. swinging gap 770 mm, Admit between centre 555 mm. Spindle bore 52 mm. Power of motor 3hp, 3phase, 50Hz. With accessories	7
34	**Hydraulic Power – Hacksaw Machine:** Length of stroke (Max.) 200mm for cutting round and square material (Max.) 150mm speed 1440 rpm. Power of motor 1.5 KW (AC 3 phase 440 volt). Accessories Vice for holding bar, saw blade, coolant pump with fittings limit switch, bar rest assembly set of wrenches and belts	7
35	**Shaping Machine:** Max. Length of stroke 450mm, Length and width of ram bearing 914 x 275 mm. Max. distance table to ram 406 mm. Min distance table to ram 100mm. Max. Horizontal travel of table 610 mm. Max. Vertical travel of table 290 mm. No. of speeds of ram 4. Max. Travel of tool slide 150 mm. Swivelling of tool slide on either side of vertical 60 Deg. Power of main drive motor 3HP, 440 V, 3 phase, 960 rpm. Accessories Auto Lubrication.	7

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
	operating handle, Vise, key way cutting attachment.	
26.	Measuring Instruments and Tools: Vernier Caliper 0 to 300mm, Dial Calipers 0-300mm, Vernier Depth Gauge 0 to 300 mm, Digital Height Gauge 0 to 450mm, Digital Micrometer 0 to 25 mm, Combination Set	7

K. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is 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
Unit– I Advanced Fitting Operations	1a. Interpret the given job drawing. 1b. Select relevant fitting tools for the specified data. 1c. Select proper raw material for the given condition. 1d. Describe the specified machinery in fitting shop. 1e. Explain the maintenance procedure of the given tool, equipment in fitting shop.	1.1 Fitting tools-Holding tools like bench vice, V-block with clamp, C-clamp. Marking and measuring tools like surface plate, angle plate, universal scribing block, try square, combination set, scriber, odd leg caliper, divider, punches, calipers, Vernier caliper, Vernier depth gauge, Vernier height gauge, outside micrometer, inside micrometer, hammers, screw driver, spanners and their Specifications 1.2 Cutting tools-Hacksaw, Chisels, combination plier, nose plier, twist drill, taps and tap wrenches, dies and die holder, bench drilling machine, portable electric drill, reamers 1.3 Finishing tools-Files: Hand file, flat file, square file, triangular file, half round file, round file 1.4 Fitting shop machines-drilling machine, power saw, grinder, their specification, care and maintenance 1.5 Basic processes - chipping, filing, scrapping, grinding, marking, sawing, drilling, tapping, dieing, reaming 1.6 Marking and measuring media, safety practices.
Unit– II Smithy shop work	2a. Describe operation sequence for a given job. 2b. Explain the function of the given tools with the help of diagrams. 2c. Describe the given machinery in smithy shop. 2d. Describe the specified operations in the smithy shop.	2.1 Tools and equipment- hearth, anvil, swage block, leg vice, hammers, tongs- flat tongs, square bit tongs, round bit tongs, pick up tongs. 2.2 Forging operations-upsetting, drawing down and fullering, flattening, swaging, bending, twisting, piercing, punching and drifting, welding, finishing, riveting, cutting(hot and cold chisel) 2.3 Safe practices

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2e. Explain the maintenance procedure for tools, equipment and machines.	
Unit– III Domestic fabrication work	3a. Select the relevant arc welding tool for welding the given job. 3b. Describe the function of the given machinery in fabrication shop. 3c. Describe the fabrication procedure in given situation. 3d. Explain maintenance procedure for the given equipment in the fabrication shop.	3.1 Arc welding equipment- Power sources for arc welding - transformers, motor generators and rectifiers 3.2 Arc welding hand tools-welding cables, electrodes, electrode holder, ground clamp, wire brush, chipping hammer, welding table and cabin, face shield, apron, hand gloves 3.3 Technique of welding- preparation of work, striking an arc, arc length, effect of current and speed, welded joints, welding positions 3.4 Operation of machinery in welding shop-arc welding transformer, their specification and maintenance 3.5 Safe practices
Unit– IV Advanced carpentry work	4a. Describe with sketches the function of the given advanced furniture making and carpentry tool(s). 4b. Select the relevant furniture making tools for the given job. 4c. Describe the operation of the given wood working machine. 4d. Explain maintenance procedure for the given equipment in carpentry shop.	4.1 Types of artificial wood such as plywood, block board, hard board, laminated boards, veneer, fibre boards and their applications. 4.2 Furniture making hand tools - Marking and measuring tools-steel rule, steel tape, marking gauge, try square, compass and divider, scriber or marking knife, level 4.3 Holding tools-carpenters vice, C- clamp, bar clamp 4.4 Planning tools-jack plane, smoothening plane, rebate plane, plough plane. 4.5 Cutting tools-saws - rip saw, cross cut hand saw, tenon saw, coping saw, chisels - firmer chisel, dovetail chisel, mortise chisel. 4.6 Drilling and boring tools-carpenters brace, hand drill, auger bit, hand drilling machine. 4.7 Miscellaneous tools-mallet, pincer, claw hammer, screw driver, wood rasp file, bradawl. 4.8 Safe practices.
Unit– V Workshop machines	5a. Describe with sketches the function of the given work and tool holding devices. 5b. Explain with sketches the working principle of the given lathe operation. 5c. Calculate speed, feed, depth of cut of lathe machine for the given	5.1 Working principle and types of lathe 5.2 Parts of lathe - bed, headstock, tailstock, carriage or saddle, compound rest, tool post, lead screw, gear box 5.3 Work holding devices-three jaw chuck, four jaw chuck, face plate, lathe dogs and driving plate 5.4 Measuring instruments-outside and inside caliper, vernier caliper, micrometer 5.5 Cutting parameters-cutting speed, feed

	job 5d. Explain working principle of the given workshop machine	depth of cut, tools materials, tools geometry. 5.6 Lathe operations: turning, Shaper machine: Working principle and operation, classification, main parts and their functions

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

- Not applicable -

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:

a. Prepare work diary based on practical performed in workshop. Work diary consist of job drawing, operations to be performed, required raw materials, tools, equipment's, date of performance with teacher's signature.
b. Prepare journals consist of free hand sketches of tools and equipments in each shop, details specification and precautions to be observed while using tools and equipment.
c. Prepare/Download a specifications of followings:
   a) Various tools and equipment in various shops.
   b) Precision equipment in workshop.
   c) Various machineries in workshop.
d. Undertake a market survey of local dealers for procurement of workshop tools, equipment, machineries and raw material.
e. Visit to fabrication/wood working/sheet metal workshop and prepare a report.

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.
f. Arrange visit to nearby industries and workshops for understanding various manufacturing process.
g. Show video/animation films to explain functioning of various processes of turning operations and shaping operations.
h. Prepare maintenance charts for various workshop machineries.
i. In respect of item 10 above, teachers need to ensure to create opportunities and provisions for such co-curricular activities.

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 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. **Black Smithy Jobs:** Each batch will collect minimum 3 different articles/jobs of black smithy from the local workshop / market. Each student will measure the significant parameters and draw the sketch. Each student will also note the material of the articles/jobs and their field applications.
b. **Fabrication Utility Jobs:** Each batch will collect information related to fabrication utility jobs including name of job, sketch, material used, fabrication process and their field applications of minimum 5 different jobs of fabrication used in our houses or purchased from the local market.
c. **Fabrication Utility Jobs:** Each batch will select at least one fabrication utility job used in civil construction and prepare steel frame / structure or utility job like window grill, ventilator, door frame or similar job involving arc welding including drawing, field application of selected job.
d. **Wood Related Jobs:** Each batch will collect minimum 4 different samples of artificial woods such as plywood, block board, fibre board, laminated boards, veneer, fiber boards etc and write their applications.
e. **Wood Related Jobs:** Each batch will collect and record the information related to furniture making tools and furnitures used in educational institutes from the local carpenter / furniture workshops with their major specifications and sketch.
f. **Miscellaneous Jobs:** Each batch will prepare jobs (like tree guard, stool stand etc) by using appropriate material and method of fabrication.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Workshop Practice	Bawa, H.S.	McGraw Hill Education, Noida, ISBN-13: 978-0070671195
2.	A Textbook of Manufacturing Process (Workshop Tech.)	Gupta J.K., Khurmi R.S.	S. Chand and Co. New Delhi, ISBN:81-219-3092-8
3.	Introduction to Basic Manufacturing Process and Workshop Technology	Singh Rajender	New Age International, New Delhi, 2014, ISBN: 978-81-224-3070-7
4.	Workshop Technology Vol-I and II	Raghuwanshi B.S.	Dhanpat Rai, New Delhi, 2014, ISBN 4567144375

14. SOFTWARE/LEARNING WEBSITES

a. http://www.asnu.com.au
b. http://www.abmtools.com/downloads/Woodworking%20Carpentry%20Tools.pdf
c. http://www.weldingtechnology.org
d. http://www.newagepublishers.com/samplechapter/001469.pdf
e. http://www.youtube.com/watch?v=TeBX6cKKHWY
f. http://www.youtube.com/watch?v=OHEQsNHrcw&feature=related
g. http://www.youtube.com/watch?v=Kx1eo9CAsM&feature=relmfu
h. http://www.piehtoolco.com
i. http://sourcing.indiamart.com/engineering/articles/materials-used-hand-tools/
j. https://www.youtube.com/watch?v=9_cnkoAbiCM

RASHTRA STATE BOARD OF TECHNICAL EDUC

Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Mechanical Engineering

Program Code : ME — **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters — **Duration : 16 Weeks**

Semester : Third — **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total		
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Strength of Materials	SOM	22306	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
2	Basic Electrical and Electronics Engineering	BEE	22310	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Thermal Engineering	TEN	22337	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Mechanical Working Drawing	MWM	22341	4	-	4	7	4	70	28	30*	00	100	40	50@	20	50	20	100	40	200
5	Engineering Metrology	EME	22342	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
6	Mechanical Engineering Materials	MEM	22343	3	-	2	5	3	70*#^	28	30*	00	100	40	25#	10	25	10	50	20	150
			Total	**19**	**2**	**14**	**35**	--	**420**	--	**180**	--	**600**	--	**175**	--	**175**	--	**350**	--	**950**

Student Contact Hours Per Week: **35 Hrs.** — Medium of Instruction- **English**

Theory and practical periods of 60 minutes each. — **Total Marks : 950**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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 LOs required for the attainment of the COs.

- For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

Program Name : **Mechanical Engineering Program Group**

Program Code : **AE/ME/PG/PT/FG**

Semester : **Third**

Course Title : **Strength of Materials**

Course Code : **22306**

1. RATIONALE

Strength of Material is a core technology subject which aims at enabling the student to understand and analyze various types of loads, stresses and strains along with main causes of change in physical properties and failure of machine parts. All Mechanical Engineering components are subjected to different loadings and behave in a specific way. The subject is pre-requisite for understanding principles of machine design and strengths of various materials used in industries. Understanding mechanical properties of materials will help in selecting the suitable materials for various engineering applications.

2. COMPETENCY

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

- **Estimate stresses in structural members and mechanical properties of materials.**

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. Compute Moment of Inertia of symmetric and asymmetric structural sections.
b. Estimate simple stresses in machine components.
c. Perform test to evaluate mechanical properties according to India Standards.
d. Compute shear force and bending moment and corresponding shear and bending stresses in beams subjected to point and uniformly distributed load.
e. Estimate stresses in shafts under twisting moments.
f. Estimate stresses in short member subjected to eccentric loading.

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
3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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*

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.

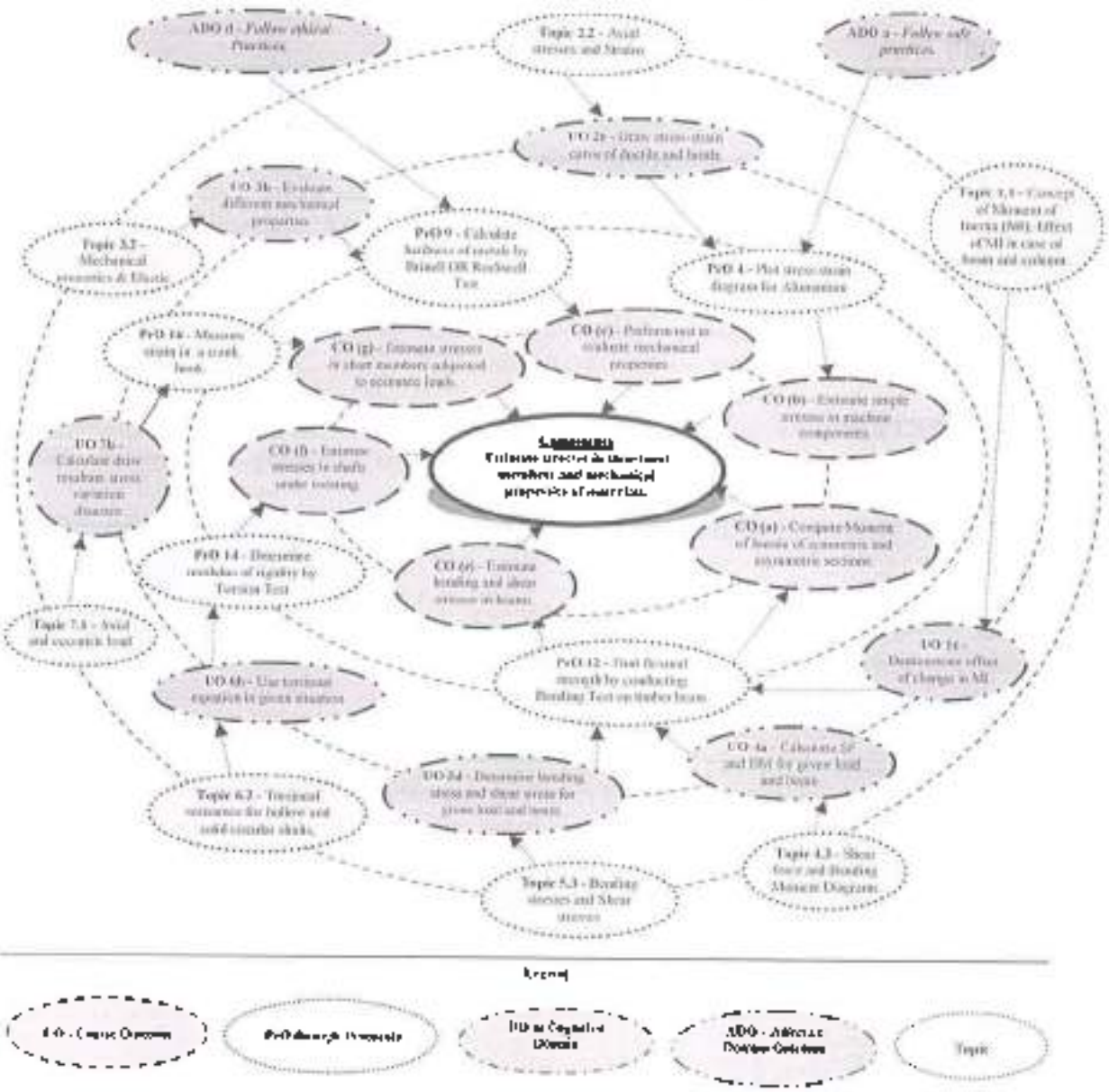


Figure 1 - Course Map

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
1	Determine yield stress, ultimate stress and breaking stress of Mild Steel by conducting Tension test as per IS432 (I)	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
2	Determine yield stress, ultimate stress and breaking stress of Mild Steel by conducting Tenston test (Part II) as per IS432 (I)	II	02
3	Plot stress-strain diagram for Aluminium by conducting Tension test (Part I) as per IS 1608	II	02
4	Plot stress-strain diagram for Aluminium by conducting Tension test (Part II) as per IS 1608	II	02
5	Calculate compressive strength of Ductile such as Mild Steel (MS), Aluminium (Al), Brass (Br), Copper (Cu), using Compression testing machine as per IS 14858	II	02*
6	Calculate compressive strength of Brittle materials such as Cast Iron (CI), High Carbon steel using Compression testing machine as per IS 14858	II	02
7	Determine shear strength of various metals such as MS, Al, Br and Cu, (Any two metals) by Single Shear test as per IS 5242	II	02*
8	Determine shear strength of various metals such as MS, Al, Br and Cu, (Any two metals) by Double Shear test as per IS 5242	II	02
9	Evaluate toughness of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Izod Impact test as per IS 1757	III	02*
10	Determine energy absorption capacity of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Charpy Impact test as per IS 1598	III	02*
11	Draw Shear force and Bending moment diagrams of given loading using open source SF/BM simulation software.	IV	02*
12	Find flexural strength by conducting Bending Test on timber beam of Rectangular cross section with shorter side horizontally oriented as per IS 1708, IS 2408	IV	02
13	Find flexural strength by conducting Bending Test on timber beam of Rectangular cross section with shorter side vertically oriented as per IS 1708, IS 2408	IV	02
14	Determine modulus of rigidity by conducting Torsion Test on MS (Part I) as per IS 1717	V	02*
15	Determine modulus of rigidity by conducting Torsion Test on MS (Part II) as per IS 1717	V	02
16	Determination of Direct stress, Bending stress and Resultant stresses for a given practical approach	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 %
a.	Awareness about significance of particular test	15
b.	Understanding working principle of machine	15
c.	Preparation of experimental set up	20
d.	Setting and operation	20
e.	Observations and recording	10
f.	Interpretation of result and conclusion	10
g.	Answer to sample questions	5
h.	Submission of report in time	5
	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 safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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
- 'Organizing Level' in 2nd year
- 'Characterizing 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	PrO. S. No.
1	**Universal Testing Machine:** Capacity - 100 tonnes. Type: Mechanical type digital, electrically Operated. Accessories: (1) Tensile test attachment for flat and round specimen up to32 mm. (2) Compression test attachment (3) Shear test attachment with sizes of bushes 5.6,8,10,12,16,20,24 mm. (4) Transverse test attachment with bending Punch,(5)Service tools,(6) Operation and maintenance manuals - 2 nos. (7)Hardness attachment	1 to 8 and 12,13
2	**Digital Extensometer:** Least count - 0.001 mm. Max. Extension = 5 mm. Single dial gauge for 30,40 mm. 60 mm. 80 mm, 100 mm, 125 mm gauge length.	1 to 2
3	**Impact Testing Machine:** CHARPY Test Apparatus: Pendulum drop angle 140°; Pendulum effective Wt 20-25 kg; Striking velocity of pendulum 5-6 m/sec; Pendulum impact energy 300 j; Min scale graduation 2 j; Distance of axis of pendulum rotation	9, 10

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
	from center of specimen to specimen hit by pendulum 815 mm. IZOD Impact Test Apparatus: Pendulum drop angle. 90°-120; Pendulum effective Wt: 20-25 kg; Striking velocity of pendulum: 3-4 m/sec; Pendulum impact energy: 168 j; Min scale graduation: 2 J, Distance of axis of pendulum rotation from center of specimen to specimen hit by pendulum : 815 mm	
4	**Torsion Testing Machine:** Fixed with auto torque selector to regulate torque ranges Contains geared motor to apply torque to specimen through gearbox Attached with autographic recorder for relation between torque and angle of twist Accuracy ± 1 % of the true torque Suitable For: Torsion and Twist test on diverse metal rods and flats Torque Measurement by pendulum dynamometer system	14, 15
7	**Compression Testing Machine:** Digital display manual control compression testing; machine; Max. Capacity (KN): 2000 : Measuring range: 4%-100% of FS; Relative error of reading: ≤ ±1%; Max. distance between two platen (mm): 330; Compression platen size (mm): 220×220; Max. piston stroke (mm): 0-20; Max. piston speed (mm/min): Approx. 30; Column clearance (mm): 300×200; Oil pump motor power (KW): 1.5; Whole dimensions (mm): 855*380*1435	12, 13
8	Strain Gages set: CEA-13-125UR-350 Strain Gages; CEA-00-125UR-350 Strain Gages; CEA-00-125UT-350 Strain Gages. With strain gauge data logger and connecting cables.	16
9	Freeware/open source software for drawing SF and BM diagrams.	11

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –I Moment of Inertia	1a. Calculate MI of the given standard shape. 1b. Calculate MI of the given simple composite shape. 1c. Explain with sketches effect of change in MI in case of the given beam and column. 1d. Calculate Polar MI and radius of gyration for the given body	1.1 Concept of Moment of Inertia (MI), Effect of MI in case of beam and column. 1.2 MI about axes passing through centroid. Parallel and Perpendicular axes theorem, Polar MI, radius of gyration. 1.3 MI of standard basic shapes. 1.4 MI of Composite plane figures.
Unit– II Simple Stress and Strains	2a. Calculate axial deformation and axial stress for the given stress condition. 2b. Use Hooke's law for	2.1 Equilibrium, Rigid body, Deformable body. 2.2 Axial Stress- meaning. Resistance. Types of stresses; Axial (linear) Strain – concept.

	given stress condition. 2c. Calculate Modulus of Elasticity and Rigidity for the given situation. 2d. Determine nature and magnitude of thermal stress in the given situation. 2e Draw stress-strain curve of the given ductile and brittle material(s) in tension. 2f. Calculate shear stresses for the given single/double shear condition	types. 2.3 Hooke's Law, Young's Modulus, Axial deformation in a body and bodies in series. 2.4 Behavior of ductile and brittle materials subjected to axial tension, stress-strain or Load-deformation curve, Limit of proportionality, yielding, permanent set, yield stress, ultimate stress 2.5 Shear stress and shear strain, Modulus of rigidity, punching shear, shear connectors, single and double shear. 2.6 Temperature stress and strain in case of bodies having uniform cross-section, deformation fully prevented, field examples.
Unit – III Mechanical Properties and Elastic Constants of Metals	3a. Identify type of deformation for the given type of load with justification. 3b. Evaluate different mechanical properties of the given material. 3c. Identify types of load acting in the given situation with justification. 3d. Identify type of material from the given data with justification. 3e. Calculate strain and axial deformation in each direction under the given bi- and tri-axial stresses. 3f. Estimate Resilience, Modulus of resilience, Proof Resilience for the given case.	3.1 Types of loads (actions) and related deformations, Flexure, torsion, shear. 3.2 Mechanical properties. Elasticity, Plasticity, Ductility, Brittleness, Malleability, Fatigue, Creep, Toughness, Hardness. 3.3 Strength, Factor of Safety, Stiffness and flexibility. 3.4 Linear and lateral strain, Poisson's ratio, changes in lateral dimension. 3.5 Uni- Bi –Tri-axial stress systems, strain in each direction, Bulk modulus, volumetric strain. 3.6 Relation between three moduli. 3.7 Stress due to Gradual, Sudden and Impact load, corresponding deformation. Strain Energy, Resilience, Proof Resilience and Modulus of resilience.
Unit-IV Shear Force - Bending Moment and Shear Stresses- Bending Stresses	4a Calculate SF and BM for the given load and beam. 4b. Draw SFD and BMD for the given loaded beam. 4c. Locate point of maximum BM and point of contra-flexure in the given case 4d Draw deflected shape of beam from the given BMD. 4e. Use flexural formula for the given bending situation 4f Draw NA and extrem	4.1 Types of Beams (Simply supported with or without overhang, Cantilever) , Types of loads (Point load, Uniformly Distributed load), Bending of beam, deflected shape. 4.2 Meaning of SF and BM, Relation between them, Sign convention. 4.3 SFD and BMD, Location of point of maximum BM, Deflected shape from BMD, Location of Point of Contra-flexure. 4.4 Theory of simple bending, Assumptions in

	fibers in bending for the given beam. 4g. Determine Section modulus and Moment of resistance for the given beam. 4h. Determine bending stress and shear stress for the given load and beam. 4i. Draw bending stress and shear stress variation diagram for the given beam.	theory of bending, Flexural formula, Neutral axis. 4.5 Moment of resistance, Section modulus. 4.6 Bending stress variation diagram across depth for cantilever and simply supported beam for symmetrical and unsymmetrical sections. 4.7 Transverse shear stress, average and maximum shear stress, Shear stress variation diagram
Unit-V Torsion	5a. Use torsional equation in the given situation 5b. Calculate torque and power transmitted by a shaft in the given situation. 5c. Determine shear stress and angle of twist in a shaft for the given power to be transmitted/torque. 5d. Determine diameter of shaft for the given shear stress/ angle of twist.	5.1 Torsion: Concept, field applications (Shaft, flange couplings, shear bolts), torsional rigidity, torsional equation and assumptions. 5.2 Torsional resistance for hollow and solid circular shafts, Power transmitted by shaft, replacement of section.
Unit-VI Direct and Bending Stresses	6a. Identify machine components subjected to eccentricity with justification. 6b. Calculate resultant stress and draw resultant stress variation diagram for the given situation. 6c. Mark core (kernel) of the given standard section. 6d. Determine size of component for the given stress condition.	6.1 Axial and eccentric load, effects of eccentricity. Field cases (Hook, clamp, Bench Vice, Frame etc). 6.2 Axial stress and bending stress, resultant stress intensities, resultant stress variation (Eccentricity about one axis only). 6.3 Limiting eccentricity, Core of section. 6.4 No tension condition.

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
I	Moment of Inertia	04	02	00	04	06
II	Simple stresses and Strains	08	02	02	06	10
III	Mechanical properties and Elastic Constants	08	02	02	04	08
IV	Shear force- Bending Moment and Shear stresses- Bending stresses	16	02	06	20	28*
V	Torsion	06	00	02	06	08
VI	Direct and Bending stresses	06	02	02	06	10
Total		**48**	**10**	**14**	**46**	**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.

* These 28 marks should be equally divided between 'Shear force- Bending Moment' and 'Shear stresses- Bending stresses', hence questions of 14 marks should be asked from each of these topics.

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. Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews.

a. Undertake micro-projects.
b. Prepare journals based on practical performed in laboratory.
c. Poster presentation on any one topic.
d. Market survey specific to properties of various type of materials used in Mechanical Engineering

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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.
f. Demonstrate students thoroughly before they start doing the practice.

g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.
i. Show video/animation film to demonstrate the testing of different materials.
j. Arrange a visit to nearby material testing lab.
k. Use flash/animations to explain the failure of different machine components under various load situations.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably 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. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty

a. Collect information and present in tabular form, values of different engineering properties of five standard mechanical engineering materials.
b. Present a seminar on different testing methods used in industry.
c. Prepare models of single and double shear conditions.
d. Prepare a model of a shaft to demonstrate relation between length and angle of twist.
e. Prepare an excel sheet to calculate SF and BM in a simply supported beam and cantilever beam.
f. Collect information comprising of different machine components subjected to direct and bending stresses.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Strength of Materials	Punmia B.C.	Laxmi Publications (p) Ltd. New Delhi. 10/e, 2015,ISBN: 9788131809259
2	Strength of Materials	Ramamurtham S.	Dhanpat Rai Publishing , New Delhi; 2014, ISBN: 9789384378264
3	Strength of Materials	Timoshenko Gere	CBS.2 edition. 2006, New Delhi, ISBN: 9788123908946
4	Strength of Materials	Khurmi R.S.	S. Chand Publishing. New Delhi, 2006 . ISBN: 9788121928229
5	Strength of Materials	Rattan S.S.	McGraw Hill Education;, New Delhi, 2016. ISBN: 9789385965517

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
b. en.wikipedia.org/wiki/Shear_and_moment_diagram
c. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
d. www.engineerstudent.co.uk/stress_and_strain.html
e. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf

Program Name : **Mechanical Engineering & Automobile Engineering Program**

Program Code : **AE / ME**

Semester : **Third**

Course Title : **Basic Electrical & Electronics Engineering**

Course Code : **22310**

1. RATIONALE

Diploma engineers (also called technologists) passouts have to deal with electrical and electronics engineering principles and applications in industrial processes of different fields. It is therefore necessary for them to apply the principles of electrical and electronics engineering. This course will make them conversant with electrical / electronic engineering aspects of manufacturing, production, fabrication, automobile and mechanical engineering based processes in industries.

2. COMPETENCY

This course is to be taught and implemented with the aim to develop in the student, the course outcomes (COs) leading to the attainment of following industry identified competency expected from this course:

- **Use electrical and electronic equipment safely in mechanical engineering applications.**

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 principles of electric and magnetic circuits to solve engineering problems.
b. Determine voltage and current in A.C. circuits.
c. Connect transformers and electric motors for specific requirements.
d. Identify electronic components in electric circuits.
e. Use relevant electronic components safely.
f. Use relevant electric/electronic protective devices safely.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		FSE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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*

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.

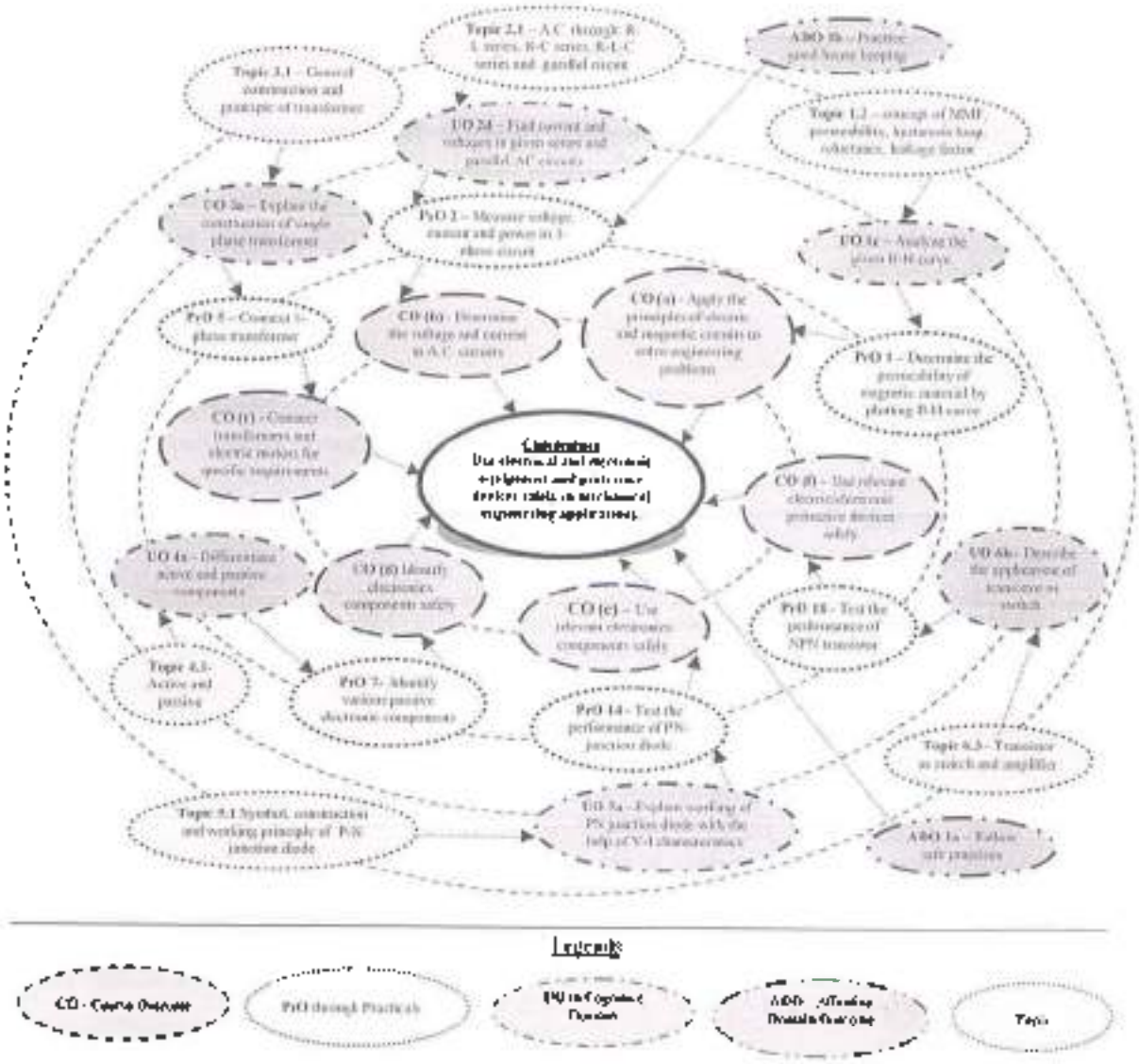


Figure 1 - Course Map

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
1	Determine the permeability of magnetic material by plotting its B-H curve.	I	02*
2	Measure voltage, current and power in 1-phase circuit with resistive load.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	Measure voltage, current and power in R-L series circuit.	II	02*
4	Determine the transformation ratio (K) of 1-phase transformer.	III	02
5	Connect single phase transformer and measure input and output quantities.	III	02
6	Make Star and Delta connection in induction motor starters and measure the line and phase values.	III	02
7	Identify various passive electronic components in the given circuit	IV	02
8	Connect resistors in series and parallel combination on bread board and measure its value using digital multimeter.	IV	02
9	Connect capacitors in series and parallel combination on bread board and measure its value using multimeter.	IV	02*
10	Identify various active electronic components in the given circuit.	IV	02
11	Use multimeter to measure the value of given resistor.	IV	02
12	Use LCR-Q tester to measure the value of given capacitor and inductor.	IV	02
13	Determine the value of given resistor using digital multimeter to confirm with colour code.	IV	02*
14	Test the PN-junction diodes using digital multimeter.	V	02*
15	Test the performance of PN-junction diode.	V	02
16	Test the performance of Zener diode.	V	02
17	Test the performance of LED.	V	02
18	Identify three terminals of a transistor using digital multimeter.	VI	02
19	Test the performance of NPN transistor.	VI	02*
20	Determine the current gain of CE transistor configuration.	VI	02
21	Test the performance of transistor switch circuit.	VI	02
22	Test the performance of transistor amplifier circuit.	VI	02
	Total		**44**

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 safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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	Pro. S.No.
1	Single Phase Transformer: 1kVA, single-phase, 230/115 V, air cooled, enclosed type.	1,5
2	Single phase auto transformer (Dimmerstat) - Single-Phase, Air cooled, enclosed model, Input: 0 ~ 230, 10A, Output: 0 ~ 270Volts	2,3,4
3	Lamp Bank - 230 V 0-20 A	17
4	Single phase Induction motor – ½ HP,230 V,50 Hz, AC supply	5
5	Different types of starters	6
6	Digital multimeter , 3and ½ digit, seprate range for resistanes and capacitance,component tester, AC and DC measurement.	7,8,11,13, 14,15,16
7	Dual trace CRO/DSO, 50MHz.	4,5,19, 20
8	Function generator,:0-2MHz. for generation of Sin ,square, pulse and triangular wave shapes	17,21,22
9	LCR-Q Meter/Tester	12

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Electrical Engineering	
Unit – I Electric	1a. Explain the given technical terms related to electric and	1.1 EMF, Current, Potential Difference, Power and Energy.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
and Magnetic Circuits	magnetic circuits. 1b. Intrepret the given B-H curve. 1c. Intrepret hysteresis loop of the given material. 1d. Apply Fleming's right hand rule and Lenz's law for determination of direction of induced emf in the given situation.	1.2 M.M.F. magnetic force, permeability, hysteresis loop, reluctance, leakage factor and B-H curve. 1.3 Analogy between electric and magnetic circuits. 1.4 Electromagnetic induction, Faraday's laws of electromagnetic induction, Lenz's law, Dynamically induced emf. 1.5 Statically induced emf.-(a) Self induced emf (b) Mutually induced emf: Equations of self and mutual inductance.
Unit– II A.C. Circuits	2a. Explain attributes of the given AC quantities. 2b. Find currents and voltages in the given series and parallel AC circuits. 2c. Derive the current and voltage relationship in the given star and delta connected circuits 2d. Determine the current and voltage in the given star and delta connection. 2e. Solve simple numerical problems related to the given AC circuits.	2.1 Cycle, Frequency, Periodic time, Amplitude, Angular velocity, RMS value, Average value, Form Factor, Peak Factor, impedance, phase angle, and power factor. 2.2 Mathematical and phasor representation of alternating emf and current, Voltage and Current relationship in Star and Delta connections. 2.3 A.C. in resistors, inductors and capacitors; A.C. in R-L series, R-C series, R-L-C series and parallel circuits; Power in A. C. Circuits, power triangle.
Unit– III Transformer and single phase induction motors	3a Explain with sketches the construction and working principle of the given type of single phase transformer. 3b Explain with sketches the working principle of the given Autotransformer 3c Describe with sketches the the construction of the given single phase motor. 3d Explain with sketches the working principle of the given single phase induction motors.	3.1 General construction and principle of different type of transformers, Emf equation and transformation ratio of transformers. 3.2 Auto transformers 3.3 Construction and Working principle of single phase A.C. motor. 3.4 Types of single phase motors, applications of single phase motors.
	Electronics Engineering	
Unit – IV Electronic Components	4a. Differentiate between the given active and passive electronic components. 4b. Calculate value of the given	4.1 Active and passive components; Resistor, capacitor, inductor symbols, colour codes, specifications.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
and Signals	resistor and capacitor using colour code. 4c. Explain the given signal parameters with sketches 4d Identify the given type of ICs based on the IC number.	4.2 Voltage and Current Sources. 4.3 Signals: waveform (sinusoidal, triangular and square), time and frequency domain representation, amplitude, frequency, phase, wavelength. 4.4 Integrated Circuits – analog and digital.
Unit– V Diodes and Applications	5a. Explain with sketches the working of the given type of diode using V-I characteristics. 5b. Locate the zener voltage on the given V-I characteristic with justification. 5c. Explain with sketches the working of the given type of rectifier using circuit diagrams. 5d. Justify selection of power supply and LEDs for the given circuit	5.1 P-N junction diode: symbol, construction , working and applications. 5.2 Zener diode: working, symbol, voltage regulator. 5.3 Rectifiers: Half wave, Full wave and Bridge Rectifier, Performance parameters: PIV, ripple factor, efficiency. 5.4 Filters: circuit diagram and working of 'L', 'C' and 'π" filter 5.5 Light Emitting Diodes: symbol, construction, working principle and applications.
Unit– VI Bipolar Junction Transistor	6a. Explain with sketches the the application of the given type of transistor as a switch. 6b. Determine the current gain of the given type of transistor configurations using transfer characteristic curve. 6c. Compare the performance of the given transistor configurations 6d. Select the type of transistors and their configurations for the given application.	6.1 BJT: symbol, construction and working principle 6.2 Transistor as switch and amplifier. 6.3 Input and Output characteristics: CE, CB and CC configurations. 6.4 Operating regions: Cut-off, saturation and Active. 6.5 Transistor parameters: CB gain α, CE gain β, input resistance, output resistance, relation between (α) and (β).

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
	Electrical Engineering					
I	Electric and Magnetic Circuits	08	02	02	04	08
II	A.C. Circuits	10	02	04	06	12
III	Transformer and single phase	14	04	06	06	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	induction motors					
	Electronics Engineering					
IV	Electronic components and Signals	10	02	04	06	12
V	Diodes and applications	10	02	04	06	12
VI	Bipolar Junction Transistor	12	02	04	04	10
Total		64	14	24	32	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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Make star delta connections of transformer.
b. Connect the various meters to measure the current and voltage of induction motor.
c. Visit site and interpret the name plate ratings and identify the parts of a transformer.
d. Present seminar on any of the above or relevant topic.
e. Conduct market survey and interpret the name plate ratings and identify the parts of an induction motor.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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.
f. Use Animations to explain the construction and working of electrical machines.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably 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. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. **Electric and magnetic circuit:** Each batch will prepare a coil without core. Students will note the deflection of galvanometer connected across the coil for: movement of the North Pole of permanent magnet towards and away from the coil (slow and fast movement), movement of the South Pole of permanent magnet towards and away from the coil (slow and fast movement). Students will demonstrate and prepare a report based on their observations. (**Duration: 8 hours**)

b **Transformer:** Each batch will visit nearby pole mounted sub-station and prepare a report based on the following points
   i. Rating: kVA rating, primary and secondary voltage, connections
   ii. Different parts and their functions
   iii. Earthing arrangement

c. **Single phase induction motor:** Each batch will select a three phase squirrel cage type induction motor for a particular application (assume suitable rating). They will visit local electrical market (if the market is not nearby you may use the Internet) and prepare a report based on the following points:
   i. Manufactures
   ii. Technical specifications
   iii. Features offered by different manufacturers
   iv. Price range

d. **Transistor as a switch:** Each batch (3-4 students) will search and study datasheet of transistor and relevant component and will build / test transistor switch circuit on breadboard/General purpose PCB for various input signal.

e. **Prepare display boards consisting of electronic components**: Each batch (3-4 students) will prepare display boards/ models/ charts/ Posters to visualize the appearance of electronic active and passive components.

f. **Diode:** Build a circuit on general purpose PCB to clamp a waveform at 3.0V using diode and passive components.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Electrical Engineering	Mittle and Mittal	McGraw Education, New Delhi, 2015, ISBN : 978-0-07-0088572-5
2	Fundamentals of Electrical Engineering	Saxena, S. B. Lal	Cambridge University Press, latest edition ISBN : 9781107464353
3	Electrical Technology Vol – I	Theraja, B. L.	S. Chand publications, New Delhi, 2015, ISBN: 9788121924405

S. No.	Title of Book	Author	Publication
4	Electrical Technology Vol – II	Theraja, B. L.	S. Chand publications, New Delhi, 2015, ISBN: 9788121924375
5	Basic Electrical and Electronics Engineering	Jegathesan, V.	Wiley India, New Delhi, 2015 ISBN : 97881236529513
6	A text book of Applied Electronics	Sedha, R.S.	S.Chand ,New Delhi, 2008 ISBN-13: 978-8121927833
7	Electronics Principles	Malvino, Albert Paul, David	McGraw Hill Eduction, New Delhi, 2015, ISBN-13: 978-0070634244
8	Principles of Electronics	Mehta, V.K. Mehta, Rohit	S. Chand and Company, New Delhi, 2014, ISBN-13-9788121924504
9	Fundamental of Electronic Devices and Circuits	Bell Devid	Oxford University Press, New Delhi 2015 ISBN : 9780195425239

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. en.wikipedia.org/wiki/Transformer
b. www.animations.physics.unsw.edu.au//jw/AC.html
c. www.alphamicon.com/altenergy/understandingAC.htm
d. www.electronics-tutorials
e. learn.sparkfun.com/tutorials/transistors
f. www.pitt.edu/~qiw4/Academic/ME2082/Transistor%20Basics.pdf
g. www.technologystudent.com/elec1/transis1.htm
h. www.learningaboutelectronics.com/
i www.electrical4u.com

Program Name : **Diploma in Production Engineering / Diploma in Production Technology / Diploma in Mechanical Engineering**

Program Code : **PG / PT / ME**

Semester : **Third**

Course Title : **Thermal Engineering**

Course Code : **22337**

1. RATIONALE

Thermal engineering forms one of the core engineering subjects for mechanical engineering students. Diploma mechanical engineers (also called technologists) have to work with various power producing and power absorbing devices like boilers, turbines, compressor, I.C. engines, and refrigerators. The course will enable students to establish foundation required to design, operate and maintain these devices. Thermal power plants are still contributing major share in electricity production in India. Thiscourse emphasizes on steam boilers and allied components that are used in many industrial sectors. Students will be able to calculate various parameters required to determine the performance of these devices.

2. COMPETENCY

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

- **Use principles of thermal engineering to maintain thermal related equipment.**

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. Apply laws of thermodynamics to devices based on thermodynamics.
b. Use first law of thermodynamics for ideal gas in closed systems.
c. Use relevantsteam boilers.
d. Use relevant steam nozzles and turbines.
e. Use relevant steam condensers.
f. Use suitable modes of heat transfer.

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
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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

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.

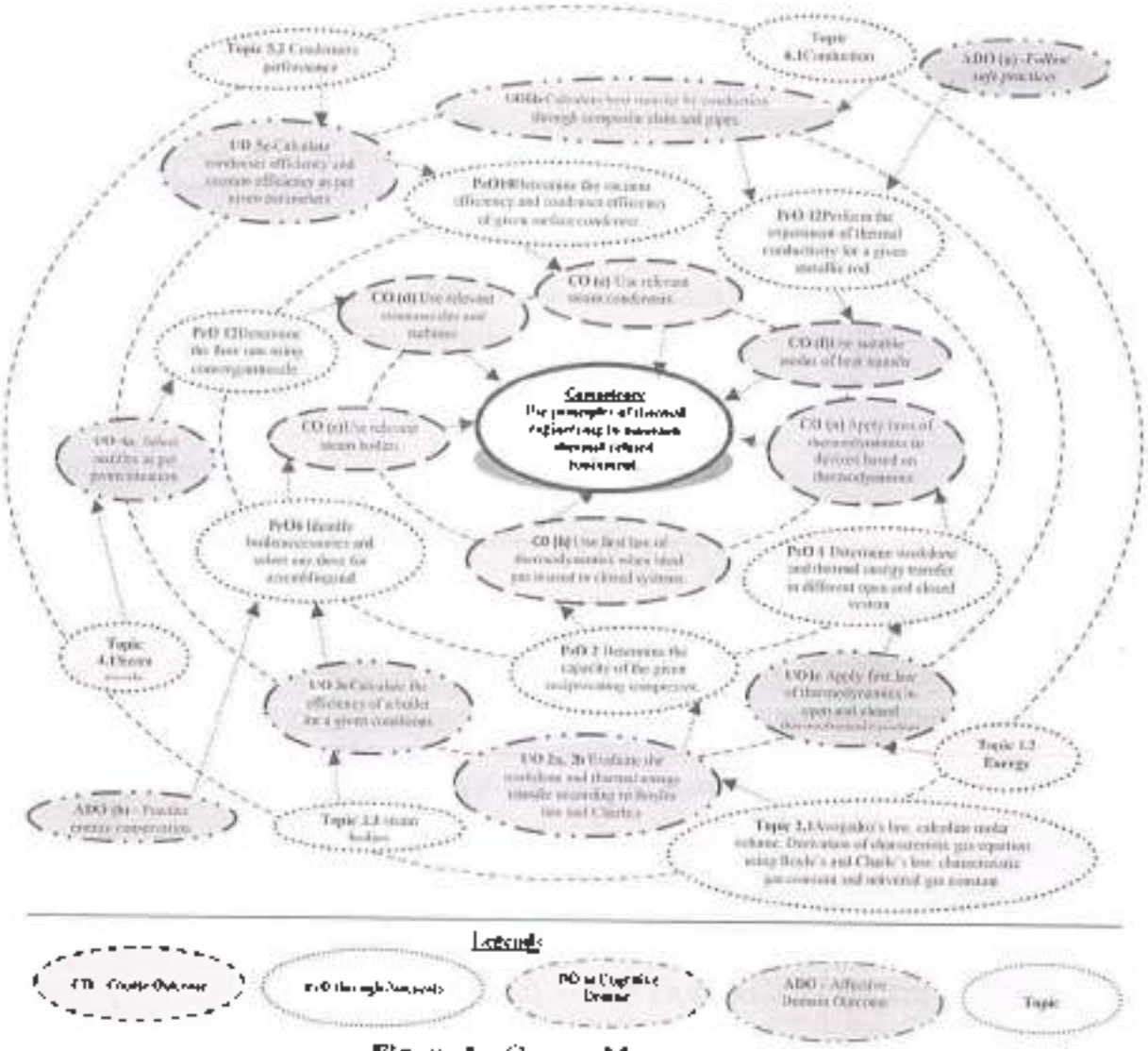


Figure 1 - Course Map

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
1	Determination of actual volume per second at the suction of reciprocating air compressor.	II	02*
2	Trace the path of Flue Gases and Water/Steam circuit of the boiler	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	Assembly and dismantling ofboiler mountings.	III	02
4	Assembly and dismantling ofboiler accessories.	III	02
5	Perform simulation of Thermal Power Plant and write specifications of boilers, turbines, condensers and electrical generators	III	02
6	Determination of dryness fraction of a given sample of steam by using separating calorimeter.	III	02*
7	Plot steam properties on Mollier chart for a given sample of wet steam.	III	02*
8	Assembly and dismantling of impulse and reaction turbines (working Model).	IV	02
9	Assembly and dismantling of cooling tower (working Model).	IV	02
10	Dismantle given model of surface condenser, draw sketches of various parts and assemble it.	V	02
11	Perform simulation software to determinethe vacuum efficiencyandcondenserefficiencyof a surface condenser using advanced simulation software.	V	02
12	Calculate the thermal conductivity of Metallic Rod.	VI	02*
13	Identify different equipment in power engineering lab having heat exchangers and classify heat exchangers. Write construction and working any 03 of above heat exchangers.	VI	02*
14	Calculate mass flow rate of one fluid using energy balance equation in heat exchanger.	VI	02*
15	Calculate convective heat transfer coefficient for the given fluid.	VI	02
16	Determine the value of Stefan-Bolzman constant for radiation.	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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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 safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Maintain tools and equipment.
f. 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
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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	PrO. S. No.
1	Two stage reciprocating air compressor with intercooler test rig. Maximum Pressure – 10 bar, digital watt meter.	2,3
2	Models of water tube and fire tube boilers (cut section models).	4
3	Various mountings and accessories of boilers for assembly and dismantling purpose.	5,6
4	Relevant simulation software.	4,
5	Cut section models of impulse turbine and reaction turbine.	9
6	Experimental setup with convergent and divergent nozzle.	12,13
7	Model of surface steam condenser with assembly and dismantling purpose.	14,15
8	Experimental setup of shell and tube steam condenser. (Minimum shell diameter 45cm).	14,15
9	Experimental set up for determination of thermal conductivity.	16,17, 18
10	Models of different heat exchangers.	19
11	Experimental set up to verify Stefan Boltzman law.	21
12	Experimental set up to determine convective heat transfer coefficient.	20

8. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of Thermodynamics	1a. Determine the properties of the given substance using thermodynamic tables 1b. Explain the phenomena when thermodynamic principles is applied to the given condition of gas 1c. Explain the phenomena when first law of thermodynamics in the given thermodynamic system. 1d. Determine the rate of workdone and thermal energy transfer during thermodynamic process in the given type of open system.	1.1 Basic Concepts - Concept of pure substance, types of systems , properties of systems, Extensive and Intensive properties, flow and non-flow processes, specific volume, temperature, density, pressure.Processes and cycles 1.2 Energy - Work, Heat Transfer and Energy Thermodynamic definition of work and heat, difference between heat and work, energy –Potential Energy, kinetic Energy, internal Energy, Flow Work, concepts of enthalpy andphysical concept of entropy. 1.3 Laws of Thermodynamics- Zeroth law, first law of thermodynamics, second law of thermodynamics, Kelvin Planks, Clausius statements and their equivalence. Reversible and irreversible processes, factors making process irreversible, reversible carnot cycle for heat engine and refrigerator. 1.4 Application of Laws of Thermodynamics Steady flow energy equation and its application to boilers, engine, nozzle, turbine, compressor and condenser. Application of second law of thermodynamics to heat engine, heat pump and refrigerator.
Unit– II Ideal Gases and Ideal Gas Processes	2a. Evaluate the workdone and thermal energy transfer according to Boyles law for the given situation. 2b. Evaluate the workdone and thermal energy transfer according to Charle's law for the given situation. 2c. Calculate the mass of a gas and its final condition parameters after undergoing Polytropic process for the given situation 2d. Determinecharacteristic gas constant of commonly used gases for the given data. 2e. Calculatedifferent energy	2.1 Avogadro's law, calculate molar volume. Derivation of characteristic gas equation using Boyle's and Charle's law, characteristic gas constant and universal gas constant. 2.2 Ideal gas processes –Isobaric, Isochoric, Isothermal, Isentropic, Polytropic, Throttling and their representation on P-V and T-S diagrams. Determination of work, heat, internal energy, enthalpy change and entropy change.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	changes during ideal gas processes for the given situation.	
Unit– III Steam and steam boiler	3a. Determine dryness fraction for the given steam sample. 3b. Represent different vapor processes on suitable co-ordinates in the given situation. 3c. Calculate the efficiency of given type of boiler for the given conditions. 3d. Calculate the rates of thermal energy transfer in the given type of boiler and superheater for the given conditions.	3.1 Steam fundamentals - Applications of steam, generation of steam at constant pressure with representation on various charts such as PV, T-S, H-S. Properties of steam and use of steam table, dryness fraction, degree of superheat, sensible and latent heat, boiler efficiency, Mollier chart. 3.2 Vapour processes – Constant pressure, constant volume, constant enthalpy, constant entropy process (numerical using steam table to determine dryness fraction and enthalpy), Rankine cycle. 3.3 Steam Boilers - Classification, Construction and working of - Cochran, Babcock and Wilcox. La-mont and Loeffler boiler, packaged boilers. Boiler draught. Indian Boiler Regulation (IBR) (to be covered in practical periods). 3.4 Boiler mountings and accessories. 3.5 Boiler instrumentation. 3.6 Methods of energy conservation in boilers.
Unit-IVSteam turbines	4a. Select the nozzles for the given situation. 4b. Determine thermal efficiency for the specified type of steam turbine for given conditions. 4c. Interpret thegiven types of steam cycles to estimate efficiencies in a steam power plant 4d. Compare the performance for the given steam turbine stages.	4.1 Steam nozzle - Continuity equation, types of nozzles, concept of Mach number, critical pressure and choked flow condition, application of steam nozzles. 4.2 Steam turbine - Classification of turbines. Construction and working of impulse and reaction turbine. 4.3 Compounding of turbines and its types. Regenerative feed heating, bleeding of steam, governing and its types, losses in steam turbines.
Unit –V Steam Condensers	5a Identify the elements and processes of the given type of steam condensers. 5b. Identify the elements and processes of the given cooling towers.	5.1 Steam condensers - Dalton's law of partial pressure, function and classification of condensers, construction and working of surface condensers and jet condensers. 5.2 Condenser performance - Sources of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	5c. Calculate condenser efficiency and vacuum efficiency for the given parameters. 5d. Evaluate the thermal performance for the given data of the team condenser 5e. Interpret the thermal design of the given type of cooling tower. 5f. Select condensers for the given situation with justification 5g. Select cooling tower for the given situation with justification	air leakage and its effect, concept of condenser efficiency, vacuum efficiency (Simple numerical). 5.3 Cooling Towers-Construction and working of forced, natural and induced draught cooling tower.
Unit-VI Heat transfer and heat exchangers.	6a. Calculate heat transfer by conduction through composite slabs and pipes for the given data. 6b. Use Stefan Boltzman law of radiation in the given situation. 6c. solve thermal engineering problems with the given data using principles of energy mechanisms. 6d. Explain construction and working of a given type of heat exchangers with sketches. 6e. Select heat exchangers for the given situation with justification.	6.1 Modes of heat transfer - Conduction, convection and radiation. 6.2 Conduction - Fourier's law, thermal conductivity, conduction through cylinder, thermal resistance, composite walls, list of conducting and insulating materials. 6.3 Convection - Newton's law of cooling, natural and forced convection. 6.4 Radiation- Thermal Radiation, absorptivity, transmissivity, reflectivity, emissivity, black and gray bodies, Stefan-Boltzman law. 6.5 Heat Exchangers - Classification, construction and working of shell and tube, shell and coil, pipe in pipe type and plate type heat exchanger, automotive heat exchanger and its applications.

Note: To attain the UOs 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
I	Fundamentals of thermodynamics	08	02	02	04	08
II	Ideal gases and ideal gas processes	08	04	04	06	14
III	Steam and steam boilers	10	02	04	08	14
IV	Steam turbines	08	04	04	08	16
V	Steam condensers	08	02	04	04	10
VI	Heat transfer and heat exchangers	06	02	02	04	08
Total			16	20	34	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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews.

a. Prepare journal of practical.
b. Prepare and present a seminar on boiler instrumentation using appropriate sources of information.
c. Prepare charts on compounding, regenerative feed heating processes.
d. Prepare charts of PV & TS charts of different ideal gas processes.
e. Prepare charts of PH, HS, TS diagrams for different steam processes.
f. Draw manually enthalpy-entropy (Mollier) chart and represent different vapor processes on the same using different color combinations.
g. Prepare a report on visit to Sugar Factory / Steam Power Plant / Dairy industry with specification of boiler and list of mountings and accessories along with their functions.
h. List insulating and conducting materials used in various applications

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably 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. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare charts on fundamentals concepts of thermodynamics. E.g. First/Second law applications, heat and work transfer.
b. Investigate energy transfer in thermodynamic system.
c. Investigate combustion process and caloritic values.
d. Prepare at least one model explaining ideal gas processes.
e. Prepare at least one model of boiler mountings and accessories.
f. Collect and analyze technical specifications of steam turbines, boilers from manufacturers' websites and other sources.
g. Prepare a report on steam traps used in steam piping.
h. Carry out comparative study of conventional cooling towers, cooling towers used in power plants and upcoming cooling towers. .
i. Make power point presentation including videos on heat exchangers commonly used.
j. Make models of Shell and Tube, Plate, tube in tube heat exchangers in workshop.
k. Organize a group discussion session on relative merits and demerits of different types of turbines, condensers, boilers.
l. Make a model of steam condenser and show how vacuum is created after steam condensation.
m. Undertake a 03 days training at Thermal Power Plant.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Thermal Engineering	Rathore, Mahesh M.	Tata McGraw-Hill Education, New Delhi 2010, ISBN: 9780070681132
2	Basic Thermodynamics	Nag, P. K.	McGraw-Hill Education, New Delhi
3	Thermal Engineering	Rajput, R. K.	Firewall Media, New Delhi 2005. ISBN 978-8170088349
4	A Textbook of Thermal Engineering	Gupta, J. K.; Khurmi R. S.	S. Chand Limited, New Delhi 1997, ISBN: 9788121925730
5	A course in Thermal Engineering	Domkundwar, S; Kothandaraman, C. P;Domkundwar, A. V.	DhanpatRai and company, New Delhi, 2004. ISBN:9788177000214

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://www.sfu.ca/~mbahrami/ENSC%20388/Notes/Intro%20and%20Basic%20Concepts.pdf
b. http://web.mit.edu/16.unified/www/FALL/thermodynamics/notes/node12.html
c. https://www.youtube.com/watch?v=9GMBpZZtjXM
d. https://www.youtube.com/watch?v=3dyxjBwqF-8
e. https://www.youtube.com/watch?v=02p5AKP6W0Q
f. http://www.learnengineering.org/2013/02/working-of-steam-turbine.html
g. https://www.youtube.com/watch?v=MulWTBx3szc
h. http://nptel.ac.in/courses/103106101/Module%20-%208/Lecture%20-%202.pdf
i. https://www.youtube.com/watch?v=Jv5p7o-7Pms
j. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Mechanical/Heat%20and%20Mass%20Transfer/Course_home_1.html
k. http://www.rinfra.com/energy_generation.html

Program Name : **Diploma in Mechanical Engineering**

Program Code : **ME**

Semester : **Third**

Course Title : **Mechanical Working Drawing**

Course Code : **22341**

1. RATIONALE

A Mechanical Engineering Diploma holder, irrespective of his field of operation in an industry, is expected to possess a thorough understanding of drawing, which includes clear spatial visualization of objects and the proficiency in reading and interpreting a wide variety of production drawings. The course aims at developing the ability to visualize and draw curves of intersection and develop lateral surfaces of various solids. Knowledge of conventional representation, limits, fits and tolerances, geometrical tolerances, surface roughness representation are also included in the course which helps in reading and drawing various production drawings. In industry, the components are manufacture on the basis of their detailed drawings. Theses drawings comprise of all the information required to produce the component. The course aims to develop ability to visualize and draw assembly and detail drawings. This course envisages reinforcing and enhancing the knowledge and skill acquired in the earlier two courses viz. Engineering Graphics & Engineering Drawing.

2. COMPETENCY

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

- **Interpret and prepare mechanical working drawing /production drawing of a given component.**

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. Draw development of lateral surface of various solids.
b. Draw intersection curves of different solids.
c. Use various drawing codes, conventions and symbols as per IS SP-46.
d. Draw production drawings used to produce products.
e. Draw assembly and detailed drawings of products.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	4	7	4	70	28	30*	00	100	40	50@	20	50	20	100	40

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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*

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.

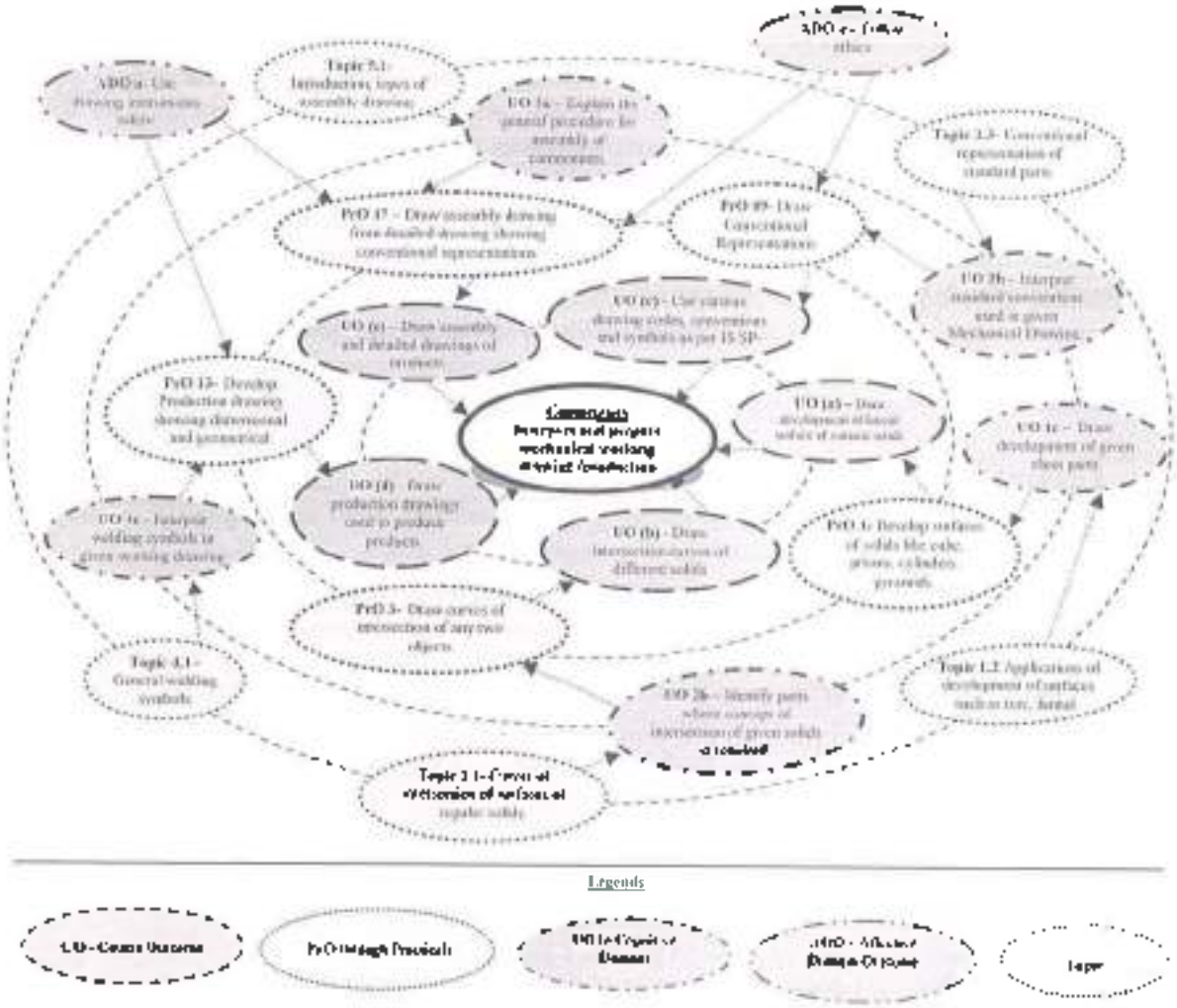


Figure 1 - Course Map

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. Following practicals are to be attempted on A2 drawing sheets.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
Sheet No.:1			
1	Develop surfaces of solids like cube, prisms, cylinders, pyramids. (Part I)		
2	Develop surfaces of solids like pyramids, cones. (Part II)	I	02
Sheet No.:2			
3	Draw curves of intersection of any two objects like Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder, Cylinder with Cone. (Part I)	II	02
4	Draw curves of intersection of any two objects like Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder, Cylinder with Cone. (Part II)	II	02
5	Draw curves of intersection of any two objects like Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder, Cylinder with Cone. (Part III)	II	02
6	Draw curves of intersection of any two objects like Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder, Cylinder with Cone. (Part IV)	II	02
Sheet No.:3			
7	Draw various Conventional Representations as per SP – 46 (1988) (Part I)	III	02
8	Draw various Conventional Representations as per SP – 46 (1988) (Part II)	III	02
9	Draw various Conventional Representations as per SP – 46 (1988) (Part III)	III	02
Sheet No.:4			
10	Draw Dimensional and Geometrical Tolerances, welding symbols, surface roughness and Machining Symbols on given figures and tables. (Part I)	IV	02
11	Draw Dimensional and Geometrical Tolerances, welding symbols, surface roughness and Machining Symbols on given figures and tables. (Part II)	IV	02
12	Draw Dimensional and Geometrical Tolerances, welding symbols, surface roughness and Machining Symbols on given figures and tables. (Part III)	IV	02
Sheet No.:5			
13	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc. (Part I)	IV	02
14	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc. (Part II)	IV	02
15	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc. (Part III)	IV	02
16	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc.	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	(Part IV)		
Sheet No.:6			
17	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part I)	V	02
18	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part II)	V	02
19	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part III)	V	02
20	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part IV)	V	02
21	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part V)	V	02
22	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part VI)	V	02
23	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part VII)	V	02
24	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part VIII)	V	02
Sheet No.:7			
25	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols (Part I)	VI	02
26	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part II)	VI	02
27	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part III)	VI	02
28	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part IV)	VI	02
29	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part V)	VI	02
30	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part VI)	VI	02
31	Draw detailed drawings from given assembly drawing showing	VI	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part VII)		
32	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part VIII)	VI	02
	Total		**64**

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, all practicals 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.	Interpretation of given problem	20
2.	Draw sheet using different drafting instrument	35
3.	Follow line work for neat and accurate drafting	10
4.	Dimensioning the given drawing and writing text	10
5.	Answers to sheet related questions	10
6.	Submit the assigned sheet on time	5
7.	Follow cleanliness and housekeeping in Drawing Hall	5
8.	Attendance and punctuality	5
	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. Use drawing instruments safely.
b. Practice cleanliness and neatness.
c. Follow ethics and standards.

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	PrO. Unit.No.
1.	Drawing Table with Drawing Board of Full Imperial/ A1 size	All
2.	Paper Models of objects for development of Lateral surfaces of solid	01. 02
3.	Models of solids showing intersection curves	03 to 06
4.	Models of machine components for conventional representation	07 to 09
5.	Actual assemblies mentioned in unit V	13 to 32
6.	Set of various production drawings being used by industries	All
7.	Specimen library of various machine components	All
8.	Set of drawings sheets mentioned in section 6.0 could be developed by experienced teachers and made available on the MSBTE portal to be used as reference/standards	All
9.	Drawing equipment's and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine) b. Set squares (45^{0} and 30^{0}- 60^{0}) c. Protractor Drawing instrument box (containing set of compasses and dividers)	All
10.	Interactive board with LCD overhead projector	All

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is 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
Unit– I Development of Surfaces	1a. Draw development of lateral surfaces of the given solid. 1b Identify parts where concept of development of the given surfaces is required. 1c. Draw development of given sheet metal/non metal parts.	1.1 Developments of Lateral surfaces of cube, prisms, cylinder, pyramids, cone. 1.2 Applications of development of surfaces such as tray, funnel.
Unit-II Intersection of Solids	2a. Identify parts where concept of intersection of the given solids is required. 2b. Draw curves of intersection of the given solid combinations.	Curves of intersection of surfaces of the regular solids in the following cases: 2.1 Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder when (i) the axes are at 90° and bisecting (ii) The axes are at 90° and Offset 2.2 Cylinder with Cone: when axis of cylinder is parallel to both the reference planes and cone resting on base on HP with axis intersecting and offset from axis of cylinder.
Unit– III Conventional Rrepresentation	3a. Use IS SP-46 (1988) codes. 3b. Interpret standard conventions used in th	3.1 Conventional breaks in pipe, rod and shaft. 3.2 Conventional representation of

	given Mechanical working Drawing. 3c. Use standard conventions in practice.	common features like slotted head, radial rib, knurling, serrated shaft, splined shaft, ratchet and pinion, repeated parts, square on shafts, holes on circular pitch, internal and external thread. 3.3 Conventional representation of standard parts like ball and roller bearing, gears, springs 3.4 Pipe joints and valves. 3.5 Counter sunk and Counter bored holes. 3.6 Tapers (As per standard conventions using IS SP – 46 (1988)
Unit– IV Production Drawings	4a. Calculate tolerances on the given machine components. 4b. Identify fit required between mating parts of machine components based on the given tolerance values. 4c. Interpret welding symbols in the given working drawing. 4d. Interpret surface roughness characteristics from the values the given on component drawing. 4e. Draw above conventional representations for the given situation.	4.1 Limits, Fits and Tolerances: a) Definitions, introductions to ISO system of Tolerance. b) Dimensional tolerances:-Terminology, selection and representation of dimensional tolerance- number and grade method. Definitions concerning Tolerancing and Limits system, unilateral and bilateral tolerance, Hole and shaft base systems, Types of fits-Clearance, transition and Interference, Selection of fit for engineering applications Calculation of limit sizes and identification of type of fit from the given sizes like Ø50 H7/s6, Ø30 H7/d9 etc. 4.2 Geometrical Tolerances: Types of geometrical tolerances, terminology for deviation, representation of geometrical tolerance on drawing 4.3 General welding symbols, length and size of weld, surface contour and finish of weld, all round and site weld, symbolic representation in Engineering practices and its interpretation. 4.4 Machining symbol and surface texture: Indication of machining symbol showing direction of lay, sampling length, roughness grades, machining allowances, manufacturing methods. Representation of surface roughness on drawing.

Unit– V Details to Assembly	5a. Explain the general procedure for assembly of components 5b. State details of components and the sequence of components of the given assembly. 5c. Draw assembly drawing from the given detailed drawing.	5.1 Introduction, types of assembly drawing, accepted norms to be observed for assembly drawings, sequence for preparing assembly drawing, Bill of Material. 5.2 Couplings: Oldham & Universal couplings. 5.3 Bearing: Roller, Foot Step & Pedestal Bearing. 5.4 Lathe: Single(pillar type) and Square tool Post. 5.5 Bench vice & Pipe Vice. 5.6 Screw Jack. 5.7 Valve: Steam stop, Non return valve. 5.8 Piston and connecting rod of IC engine. 5.9 Lathe machine: tail stock 5.10 Drill Jig 5.11 Any other assembly consisting of 6 - 10 parts.
Unit– VI Assembly to Details	6a. Identify various components in the given assembly and the sequence of dismantling it 6b. Describe the procedure for dismantling the assembly into components. 6c. Draw detailed drawing from the given assembly drawing.	6.1 Basic principles of process of dismantling the assembly into components. 6.2 Details of all assemblies mentioned in unit V.

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
I	Development of surfaces.	08	-	-	08	08
II	Intersection of solids	12	-	-	14	14
III	Conventional representation.	04	06	-	-	06
IV	Production drawing	08	02	08	-	10
V	Details to Assembly	16	-	04	12	16
VI	Assembly to Details	16	-	04	12	16
Total		**64**	**08**	**16**	**46**	**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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Student should maintain a separate A3 size sketch book which will be the part of term work and submit it along with drawing sheets. Following assignment should be drawn in the sketch book
   i. Minimum 5 problems each on Unit No I and II.
   ii. Minimum 2 problems each on Unit No III to VI.
   Note- Problems on sheet and in the sketch book should be different.
b. Students should collect Production drawings from nearby workshops/industries and try to visualize the part from the given views
c. Prepare paper models of development of lateral surfaces of solids
d. Visit any sheet metal workshop and prepare a report related to type of components, dimensions, material, area of application, raw material required, name of operations performed.
e Prepare clay/ paper models of solids showing curves of intersection

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 section 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
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students during practice.
i. Arrange visit to nearby industries and workshops for understanding various production drawings.
j Show video, animation films, solid modeling software to explain intersection of solid, Assembly and details
k. Prepare wall charts for Dimensional and Geometrical Tolerances.

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 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. Visit nearby fabrication workshop and prepare report on various types of welding symbols used for fabrication work.
b. Visit nearby process industries like sugar factory, chemical industries etc and prepare report representing conventional representation of various piping joints.
c. Visit Institute's Power engineering Lab and prepare detailed drawings of Various IC Engine components using proper measuring instruments.
d. Visit Institute's workshop and prepare assembly drawing and working drawing of machine vice/ lathe tailstock/ tool post etc
e. Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Machine Drawing	Bhatt N.D., Panchal V.M.	Charotar Publishing house Pvt. Ltd., Anand, Gujarat, 2013. ISBN 9789380358635
2	Engineering Drawing practice for schools and colleges IS : SP- 46	Bureau of Indian standard	BIS Delhi, Third reprint, October 1998 ISBN 8170610912
3	Production Drawing	Narayanan L.K., Kannaich P., VenkatReddy K.	New Age International Publication, New Delhi, 2009 ISBN: 9788122435016
4	Engineering Drawing	Bhatt N.D.	Charotar Publishing house Pvt. Ltd. Anand, Gujarat, ISBN:9789380358178
5	A text book of Machine Drawing	Gill P.S.	S.K.Kataria and Sons, New Delhi,2007, ISBN: 9789350144169
6	Machine Drawing	Sidheshwar	McGraw Hill, New Delhi, 2009 ISBN : 9780074603376

14. SOFTWARE/LEARNING WEBSITES

a. sketch up 7 software for solid modelling
b. http://www.weldingtechnology.org
c. http://www.newagepublishers.com
d. Engineering graphics and Drawing v 1.0 from cognifront
e. http://www.youtube.com/watch?v=o1YPja2wCYQ
f. http://www.youtube.com/watch?v=9AGD4tihiCo&feature=plcp
g. http://www.youtube.com/watch?v=n6[illegible]
h. http://www.youtube.com/watch?v=tyBYsSeNUQ

i. http://www.youtube.com/watch?v= M5eYB6056M
j. http://www.youtube.com/watch?v=UyROI-bAMu4
k. http://www.youtube.com/watch?v=eixBxbqb93s
l. http://www.youtube.com/watch?v=kWOI6tlDTBc
m. http://www.youtube.com/watch?v=gJbrO2jtoa8&feature=related
n. http://www.youtube.com/watch?v=PXgkBadGHEE
o. Engineering Graphics & Drawing v 1.0 from Cognifront
p. http http://npkauto.com/assignments


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Diploma in Mechanical Engineering**

Program Code : **ME**

Semester : **Third**

Course Title : **Engineering Metrology**

Course Code : **22342**

1. RATIONALE

Measurement activities are given prime importance in industry. The diploma technicians often come across measuring different parameters of machined components and the appropriate fitment of interchangeable components in the assemblies. The student has to identify the variables to be measured, decide the accuracy required, select the instrument, investigate reasons for defects and give suggestions, decide whether to accept or reject the jobs, suggest methods of salvaging the defective material manufactured. The different methods and instruments which can be used for linear and angular measurements, geometrical parameters (like surface finish, Squareness, Parallelism, Roundness etc) and the use of gauges and system of limits, fits, tolerances etc. are often required to be dealt in detail by a diploma engineer on the shop floor. Therefore, this course attempts to impart the necessary knowledge and develop the required abilities so that he can perform his job efficiently and effectively in modern industry.

2. COMPETENCY

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

- **Use relevant instruments to measure various parameters of machine components.**

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 the relevant instrument for measurement.
b. Use different types of comparators.
c. Select gauges, fits and tolerances for machine components.
d. Use relevant instruments to measure different parameters of screw thread and gear.
e. Use linear and angular measuring instruments.
f. Select relevant surface testing methods.

4 TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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***

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.

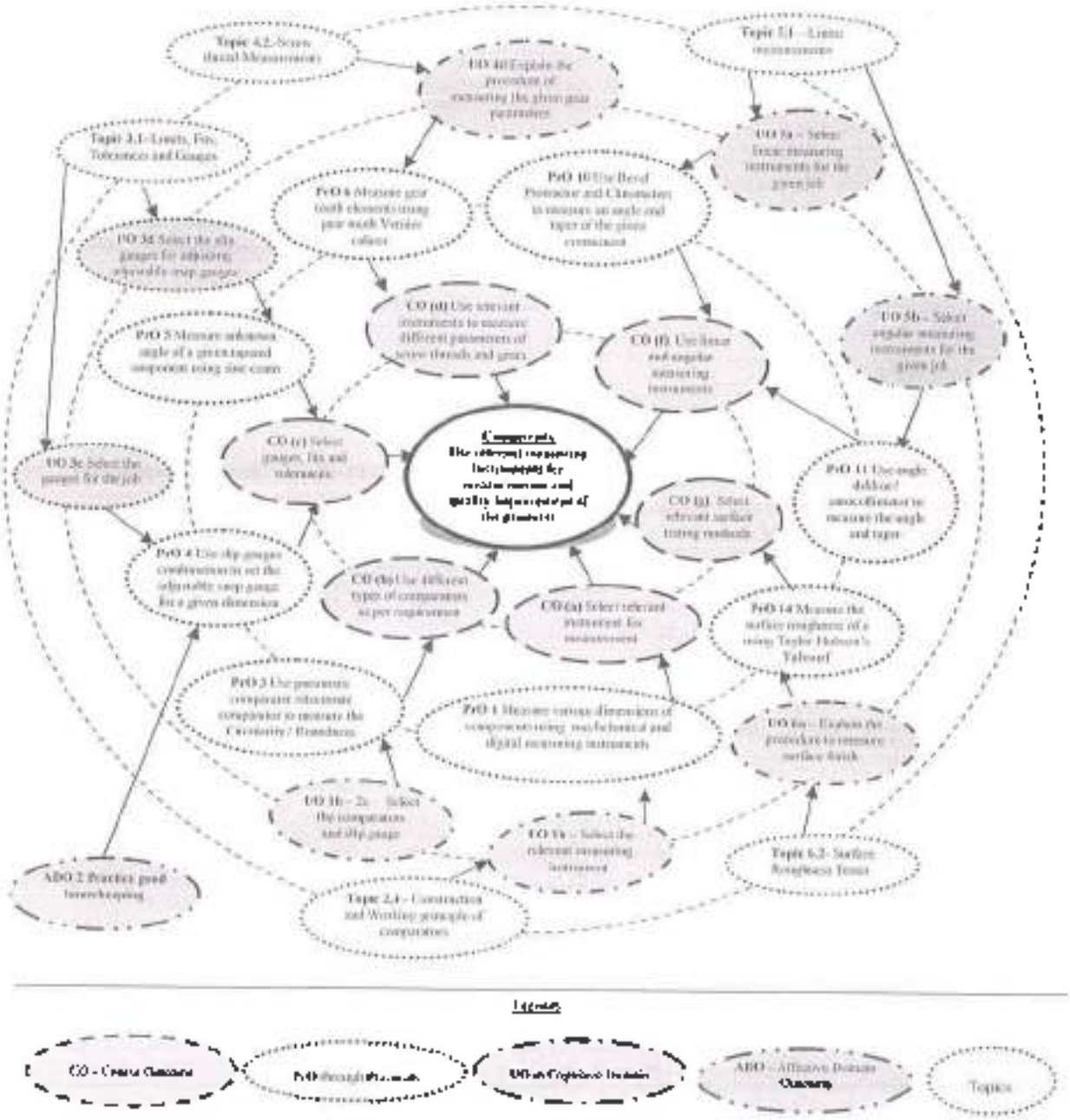


Figure 1 - Course Map

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
1	Measure various dimensions of a given components using radius gauge, Vernier caliper, Vernier height gauge, micrometer (use both mechanical and digital).	I	02
2	Measure bores of a give sample using internal micrometers and dial bore indicators.	II	02*
3	Use pneumatic comparator /electronic comparator to Measure the Circularity / Roundness of the given specimen and compare it with the given standard	II	02
4	Use slip gauges combination to set the adjustable snap gauge Go end and No-Go end for a given dimension.	III	02*
5	Measure gear tooth elements using gear tooth Vernier caliper.	IV	02
6	Measure the effective diameter of the screw thread using profile projector / Tool maker Microscope	IV	02*
7	Use floating carriage micrometer to measure minor, major and effective diameter of screw thread.	IV	02*
8	Measure unknown angle of a given tapered component using sine centre in combination with slip gauges.	V	02
9	Use Bevel Protractor and Clinometers to measure an angle and taper of the given component.	V	02*
10	Use angle dekkor / autocollimator to measure the angle and taper of given component	V	02*
11	Measure flatness of the given component by interpreting fringes using monochromatic light source and optical flat.	VI	02
12	Measure flatness of a given surface plate using spirit level.	VI	02*
13	Measure the surface roughness of a given sample using Taylor Hobson's Talysurf / surface roughness tester.	VI	02*
14	Use dial indicator to check the Lathe machine parameters like parallelism, squareness, trueness, alignment.	VI	02
15	Measure run out of cylindrical component using dial indicator.	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 24 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.	Prepare experimental set up	10

S. No.	Performance Indicators	Weightage in %
2.	Handling of measuring instruments precisely during performing practical.	30
3.	Follow Safety measures	10
4.	Accuracy in Measurement	20
5.	Answers to questions related with performed practices.	10
6.	Submit journal report on time	10
7.	Follow Housekeeping	5
8.	Attendance and punctuality	5
	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. Maintain tools and equipment
f. 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	PrO S.No.
1	Vernier Calliper-0-200mm (Mannual)	1
2	Digital Vernier Caliper- 0-200mm	1
3	Radius gauge (0.01mm to 14mm)	1
4	Screw pitch gauge – mm and TPI	1
5	Filler gauge (0.01 to 1.9mm)	1
6	Micrometer-0-25mm, 25-50mm.	1
7	Dial Micrometer (0- 25mm).(25-50mm)	1
8	Surface Plate-Granite. (200 x200x 50)	1
9	Vernier Height and Depth Gauge (mechanical and digital) 0-300mm	1
10	Micrometer Depth Gauge. (0-150mm)	1
11	Sine Bar, Sine Centre (0-200mm)	7
12	Slip Gauge set- Grade 1, 87 Pieces	2,7
13	Angle gauges box, Grade I	7

S. No.	Equipment Name with Broad Specifications	PrO S.No.
14	Universal bevel protractor:Graduation: 5min.(0°- 90°- 0°) Blade 150, 300 mm.	8
15	Angle dekkor and Autocollimator (0 to 30')	9
16	Profile projector with gear profile/Thread profile Templates: Opaque fine grained ground glasss screen with 90°, 60°, 30° cross line Location; fitted with graduated ring (0-360°) L.C. 1min; Optics Std 10X, 20X, Measuring Range Std 100mm x 100mm; Opt X axis upto 400mm, Y axis upto 200mm; Focusing Travel 100mm: Magnification Accuracy Contour ±0.05% Surface ~0.05%, Illumination Countor 24V/150W halogen lamp with illumination control; Resolution 0.005/0.001/0.0005 mm.	5
17	Screw pitch gauge. (0-25mm)	4
18	Floating Carriage Micrometer: Least count: 0.001 mm; Standard micrometer or electronic type; Non rotary 8mm micrometer spindle; Indicator with 0.001mm std dial; Admit between center 200 mm; Max Diameter capacity 100mm; Standard Accuracy + or – 0.005mm;	6
19	Monochromatic light source unit – 1 unit Light Source: 35W Sodium Wavelength: 0.575 micron; Power 220V/50HZ (110V available on request)	10
20	Optical flat set Range (0.2μm) Diameter/thickness 45/12mm and 60/15mm.	10
21	Gauges-plug (3piece) Grade A/X	2,3,6
22	Snap gauge- adjustable/ double ended (3piece) Grade A/X	3
23	Steel Ring gauges: Grade A/X, 1.5-2.00, 2.0-4.0, 4.0-12.0, 12.0-20.0 mm	2,3
24	Dial Indicator(0-25mm) with magnetic stand	12
25	Clinometer Base length: 200 mm / 1000 mm • Measuring range: ± 17.5 mm/m (= 1°) • Sensitivity per Digit: ± 0.001 mm/m • Accuracy: < ± 0.2% (full scale) • Linearity: < ± 0.2% (full scale) • Operating temperature: – 10° to + 40°C	8
26	Gear tooth vernier caliper (0-25mm)	4
27	Spirit Level: Base length : 200 mm + 1 mm; Base width : 20 mm + 0 – 1; Height : 25 + 1 mm; Bubble opening : 50 mm x 8 mm (length x width); Sensitivity : 2 Min. 30 Sec per 2 mm arc division of the vial; Least count of graduation : 2 mm; Effective length of bubble : 20 + 1 mm	12
28	Tool maker's microscope: Dimensions 152 x 152mm; Stage glass size 96 x 96mm; Feeding range 50 x 50 mm; Maximum height 115mm x 107mm; Workpiece 5Kg; Light source 24V, 2W (special bulb); Continuously adjustable light intensity; Green filter.	5
29	Parkinson's Tester/ Gear Rolling Tester with master gears Accuracy 0.25mm, Gear diameter of 40-80mm, Base size 320 x 100mm, Prject magnification 5x. Involute profile testing.	4
30	Roundness measuring machine (0-1000mm)	13
31	Pneumatic comparator – Air gauge unit with compressor; Generated pressure range (-0.95–60)bar; media. Air. Adjust resolution:0.1mbar(10Pa): Buna-N for seals; Output interface connection:M20×1.5Female.	2
32	Electronic Comparator: Work Base high chrome high carbon, hardened, ground & lapped; A precision electronic probe is provided with the unit with a measuring range of +/- 2.0 m.m; Counter : A single line display counter unit resolution 0.0001 m.m, 0.001 m.m.	2
33	Surface roughness Taylor Hobson's Tester (max. sample length 0.8mm)	11

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should 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
Unit – I Introduction to Metrology	1a. Explain the testing parameters used for the given instrument. 1b. Select the relevant measuring instrument for the given job with justification. 1c. Select the various measuring standards as per situation with justification. 1d. Calculate the least count of all basic measuring instruments.	**Metrology Basics** 1.1 Definition of metrology, objectives of metrology. 1.2 Categories of metrology. Scientific metrology, Industrial metrology, Legal metrology. 1.3 Need of inspection, Precision, Accuracy ,Sensitivity, Readability, Calibration, Traceability, Reproducibility. 1.4 Sources of errors, Factors affecting accuracy. 1.5 Selection of instrument, Precautions while using an instruments for getting higher precision and accuracy. 1.6 Concept of least count of measuring Instrument.
Unit– II Standards and Comparators	2a. Select the various measuring standards for given situation with justification. 2b. Explain the construction and working principle of the given comparator. 2c. Select the comparators and slip gauge for the given job.	2.1 Definition and introduction to line Standard, end standard, Wavelength standard and their comparison. 2.2 Slip gauge and its accessories. 2.3 Definition and Requirement of good comparator, Classification, use of comparators 2.4 Construction and Working principle of comparators- Dial indicator, Sigma Comparator, Pneumatic comparator- high pressure differential type 2.5 Relative advantages and disadvantages.
Unit– III Limits, Fits, Tolerances and Gauges	3a. Apply limits, fits and tolerances on the given job. 3b. Select grades, fits and tolerances from tolerance chart for the given sample. 3c. Select the gauges for the given job with justification. 3d. Select the slip gauges for adjusting adjustable snap gauges with	3.1 Concept of Limits and Fits, deviation and Tolerances. 3.2 Basic Terminology, Selective Assembly, Interchangeability. 3.3 Indian standard (IS 919-1993) Fits, types of fits,Hole and Shaft Basis System, guide for selection of fit. 3.4 ISO system of limit and fit,(Numerical on finding the limit and tolerances of hole andshaft assembly). 3.5 Gauges: Limit gauges, Taylors principle of gauge design Plug, Ring Gauges, snap gauges, adjustable snap gauge.

	justification.	
Unit- IV Screw thread Measurements and Gear Measurement	4a. Calculate screw thread Parameters using the given method. 4b. Identify different elements of the given screw thread. 4c. Explain different types of errors in thread and pitch of the given screw thread. 4d. Explain the procedure of measuring the given gear parameters.	4.1 Screw thread terminology, Errors in threads and Pitch 4.2 Measurement of different elements such as major diameter, minor diameter, effective diameter, pitch diameter , Best size of wire Two wire method, Thread gauge micrometer. 4.3 working principle of floating carriage micrometer. 4.4 Introduction to Tool Maker's Microscope, applications and working principle. **Gear Measurement** 4.5 Analytical and functional inspection of Gear, Measurement of tooth thickness by constant chord method and base tangent Method by Gear Rolling tester / Parkinson's Gear Tester. 4.6 Measurement of tooth thickness by Gear tooth Vernier and Profile projector Errors in gears such as backlash, run out.
Unit– V Linear and Angular Measurement	5a. Select linear measuring instruments for the given job with justification. 5b. Select angular measuring instruments for the given job with justification. 5c. Explain the concept of angular measurement with the help of given sample. 5d. Explain the procedure of measuring angles using different instruments for the given job.	5.1 Concept of linear measurement and its instruments: surface plate, V-block, calipers, combination set, depth gauge, vernier instruments, micrometer instruments, slip gauges. 5.2 Concept of angular measurement. 5.3 Instruments for angular Measurements. 5.4 Use and working of universal bevel protractor, sine bar, spirit level. 5.5 Principle of Working of Clinometers, Angle Gauges (With Numerical on Setting of Angle Gauges), Angle dekkor as an angular comparator.
Unit–VI Other Measurements	6a. Explain the procedure to measure surface finish of the given components 6b. Select machine tool test and alignment test for the given job with justification.	6.1 Primary and secondary texture, terminology of surface texture as per IS 3073-1967, CLA, Ra, RMS, Rz values and their interpretation, Symbol for designating surface finish on drawing. 6.2 Various techniques of qualitative analysis, working principle of stylus probe type instruments, Surface

	6c. Measure the surface finish of the given components. 6d. Explain the procedure for measuring complex dimensions of the given job using CMM.	Roughness Tester, Interferometry. 6.3 Parallelism, Straightness, Squareness, roundness, run out, alignment tests of Lathe and Drilling, machine tools as per IS standard. 6.4 Flatness testing using Monochromatic light source with optical flat, Introduction to CMM.

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
I	Introduction to Metrology	06	02	04	04	10
II	Standards and Comparators	10	02	04	04	10
III	Limits, Fits ,Tolerances and Gauges	08	02	04	06	12
IV	Screw thread Measurements and Gear Measurement	08	02	04	06	12
V	Linear and Angular Measurement	08	04	04	04	12
VI	Other Measurements	08	04	04	06	14
Total		48	16	24	30	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. Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews

a. Prepare journal based on practical performed in Metrology laboratory .Journal consist of drawing, observations , required measuring tools, equipments, date of performance with teacher signature.
b. Prepare/Download a specifications of followings:
   i. Measuring Tools and equipment in Metrology laboratory.
   ii. Machineries in Metrology laboratory
c. Undertake a market survey of local dealers for Measuring equipments and prepare a report.
d. Visit to any Tool room and prepare a report consisting
   i. Different advanced Measuring Instruments
   ii. Different Measuring standards and Calibration process
   iii. Cure and maintenance of measuring instruments observed

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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.
f. Arrange visit to nearby industries for understanding various Measuring processes.
g. Show video/animation films to explain functioning of various measuring Instruments.
h. Give Micro projects.
i. Use different instructional strategies in classroom teaching.
j. In respect of item no.10 above the teachers need to ensure to create opportunities and pursue for such co-curricular activities.

12. SUGGESTED TITLES OF MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably 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. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Comparative study of various linear measuring Instruments Like Steel Rule, Inside – outside Calliper, Inside-outside Vernier caliper, Inside-outside Micrometer, Digital Vernier caliper, Digital Micrometer (any one) with proper justifications.
b. Comparative Study of surface finish of Various Samples manufactured by various manufacturing processes (min.3) using surface roughness instruments with proper justification
c. Collect information of Coordinate Measuring Machine and prepare a report.
d. Comparative study of different parameters of Spur gear (Min. 5) having same module using appropriate instruments.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Engineering Metrology	R K Jain	Khanna Publication, New Delhi, 2014, ISBN-10: 817409153X
2.	Metrology and Measurement	A K Bewoor and V A Kulkarni	McGraw Hill Education (India) Pvt. Ltd. , New Delhi, 2017, ISBN13-9780070140004
3.	Engineering Metrology and Measurement	S B Raghvendra and Krishnamurthy	Oxford Publication, New Delhi, 2013, ISBN-13: 978-0198085492
4.	Measurement and Metrology	R K Rajput	S.K. Kataria and Sons, New Delhi, 2013, ISBN-13: 978-9350142301
5	Engineering Metrology for Engineers	J. F. W. Galyer and C.R. Shotbolt	Prentice Hall Publication, New Delhi, 2007, ISBN-10: 8179928486

14. SOFTWARE/LEARNING WEBSITES

a. http://nptel.ac.in/courses/112106138
b. https://cosmolearning.org/video-lectures/pyrometry-cont
c. Tangram Software for CMM
d. Dong-Do software for Electronic comparator
e. https://www.youtube.com/watch?v=VpmZjlsV4C4
f. www.youtube.com/watch?v=qNIJZYAk9pI
g. https://www.youtube.com/watch?v=xevNIIHHY9o
h. https://www.youtube.com/watch?v=DxdFiIDrFBc
i. https://www.youtube.com/watch?v=-_ZeUgVjajc
j. https://www.youtube.com/watch?v=iTjBPHtADA4
k. https://www youtube.com/watch?v=l4h644S_64w
l. https://www youtube.com/watch?v=XQT6RSNN9sA
m. https://www.youtube.com/watch?v=FgNAIKTTNtE
n. https://www.youtube com/watch?v=sLZeR7RMGFA
o. https://www.youtube.com/watch?v=QGBRwXwxnuU
p. https://www.youtube.com/watch?v=jTbRMMgbnNU
q. https://www.youtube.com/watch?v=KeZ5CfPOlBc
r. https://www.youtube.com/watch?v=3hOVfbGSQ0c
s. https://www.youtube.com/watch?v=80sNyYPTXPA
t. https://www youtube.com/watch?v=EWqThb9Z1jk
u. https://www.youtube com/watch?v=j-u3IEgcTiQ
v. https://www.youtube.com/watch?v=CLEP5LQ-y0I

Program Name : **Diploma in Mechanical Engineering**

Program Code : **ME**

Semester : **Third**

Course Title : **Mechanical Engineering Materials**

Course Code : **22343**

1. RATIONALE

With the advances made in the field of material science millions of materials are now available to cater various need of mankind. These needs and service conditions dictate the properties to be developed in the materials therefore the subject mechanical engineering materials has attracted lot of attention. Materials like ferrous and non ferrous metals, polymer, ceramics and composites are widely used in verity of engineering applications. This course deals with these materials along with advance materials, their metallurgical considerations, heat treatment processes, structure property relationship and applications. This course will enable diploma engineering students to identify variety of material and their selection for various applications.

2. COMPETENCY

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

- **Use relevant mechanical engineering materials in different applications.**

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. Identify properties of materials.
b. Select relevant ferrous materials for mechanical components.
c. Select relevant cast iron for the engineering application.
d. Use non-ferrous metals for mechanical components.
e. Suggest relevant advanced materials for mechanical components.
f. Select relevant heat treatment process

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70*@	28	30*	00	100	40	25@	10	25	10	50	20

(#):Online Exam, (*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 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*

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.

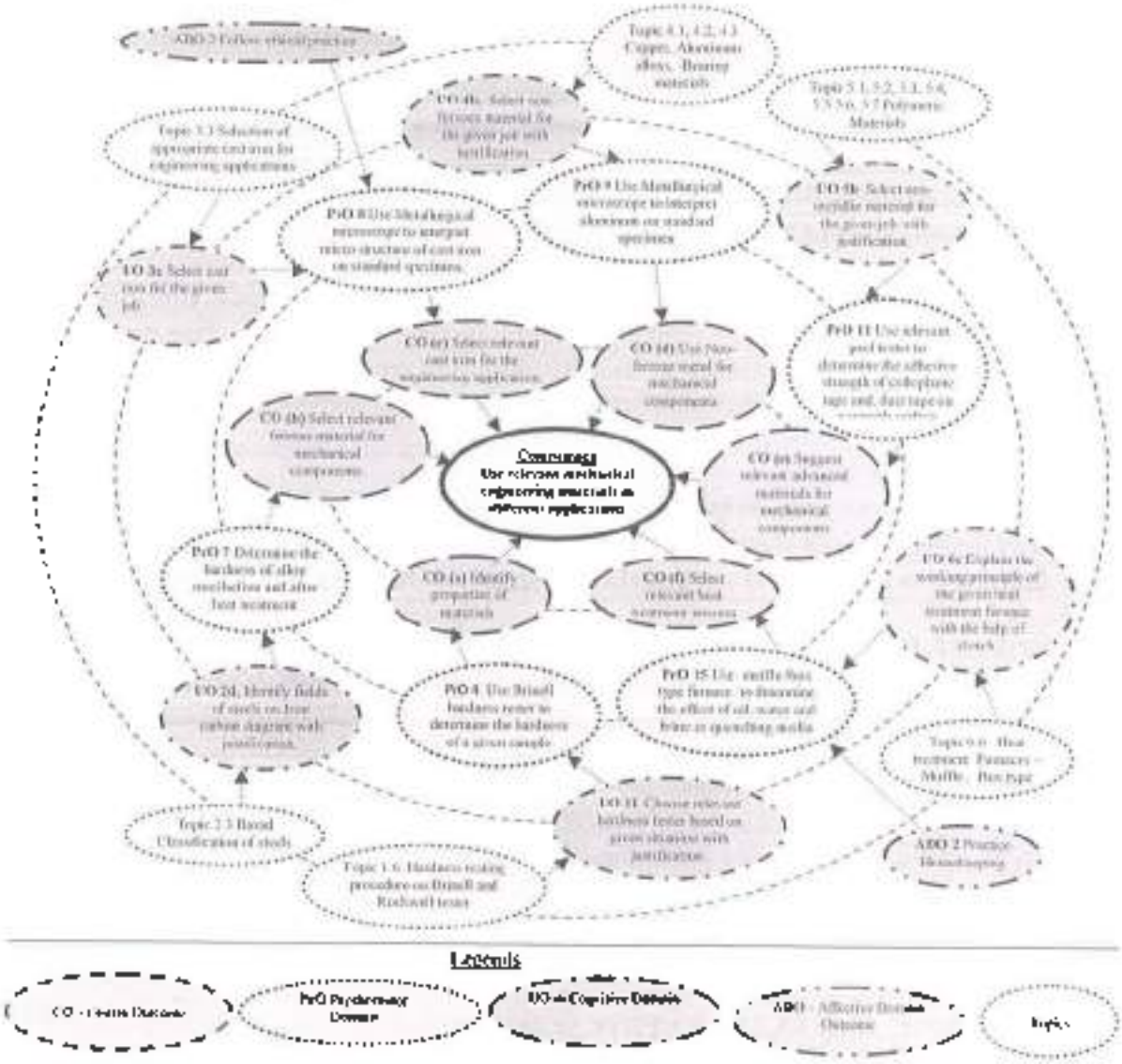


Figure 1 - Course Map

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
1	Prepare specimen of a given material for microscopic examination.	I	2*
2	Use metallurgical microscope to interpret micro structure of steels and alloy steels on standard specimen.	I	2
3	Use Brinell hardness tester to determine the hardness of a given	I	2*

S. No	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	sample.		
4	Use Rockwell Hardness tester to determine the hardness of given sample.	I	2*
5	Use relevant hardness tester to determine the hardness of mild steel before and after heat treatment.	II	2
6	Use relevant hardness tester to determine the hardness of alloy steel before and after heat treatment.	II	2*
7	Use Metallurgical microscope to interpret micro structure of cast iron on standard specimen.	III	2*
8	Use Metallurgical microscope to interpret aluminum on standard specimen.	IV	2
9	Use relevant hardness tester to determine the hardness of copper.	IV	2*
10	Use relevant peel tester to determine the adhesive strength of cellophane tape and, duct tape on a smooth surface.	V	2*
11	Perform flame test to identify different types of plastics.	V	2
12	Use High-temperature oven or electrical current to Identify behavior of the shape-memory alloy as a function with regards to temperature.	V	2*
13	Use relevant peel tester to determine the adhesive strength of scotch tape, electrical tape and masking tape on a smooth surface.	V	2
14	Use muffle /box type furnace to compare • the effect of ***oil*** as quenching media on the hardness of mild steel • the effect of ***water*** as quenching media on the hardness of mild steel • the effect of ***Brine*** as quenching media on the hardness of mild steel	VI	4*
	Total		**30**

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	10
2.	Prepare sample using different operations	30
3.	Check the microstructure and hardness of the sample	30
4.	Follow Safety measures	10
5.	Observations and Recording	5
6.	Interpretation of result and Conclusion	5
7.	Answer to sample questions	5
8.	Submission of report in time	5

S. No.	Performance Indicators	Weightage in %
	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 safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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
- 'Organizing Level' in 2nd year
- 'Characterizing 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	PrO. No.
1	Metallurgical Reflected light Microscope 6V, 30W halogen Light,200x magnification,191x126x100 mm specimen stage .Size With 100 mm travel	1,2,3,4,
2	Slitting Machine- Slitting width- standard 300 mm or extensible. Slitting blade, Slitting each width at least 15 mm	2,3,4,
3	Polishing Machine Grinding/polishing disc diameter: 200mm. Rotation speed: 0-600 rpm	2,3,4
4	Digital Rockwell hardness tester- Easy-to-use Electronics Console Hi/Lo Tolerance Settings, Adjustable Time @ Load Average Test Group Results 2-9; Test Result Memory Capacity 5000 results. RS232 Output,- Average Range.	5,6,7
5	Digital Brinell Hardness Machine- Hardness range HBW-125	5,6,7
6	Laboratory box furnaces 1200°c	11,12,14
7	Peel Tester	10,13

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Engineering Materials	1a. Interpret crystal structure of the given material. 1b. Interpret the structure of specified materials at the given level. 1c Identify microstructure of the given material with justification. 1d. Explain with sketches the procedure to prepare given sample. 1e. Explain with sketches procedure of hardness testing for the given tester. 1f. Choose relevant hardness tester based on the given situation with justification.	1.1 Classification of engineering materials, 1.2 Crystal structure, Unit cell and space lattice 1.3 Microstructure, types of microscopes 1.4 Sample preparation, etching process, types of etchant. 1.5 Properties of metals Physical Properties, Mechanical Properties. 1.6 Hardness testing procedure on Brinell and Rockwell tester
Unit – II Steel and its Alloys	2a. Interpret the given equilibrium diagram. 2b. Use the Iron –carbon equilibrium diagram for the given application. 2c. Identify the given phase diagrams and reactions with justification. 2d. Identify the given fields of steels on Iron carbon diagram with justification. 2e. Select relevant steel for the given application with justification.	2.1 Concept of phase, pure metal, alloy and solid solutions. 2.2 Iron Carbon Equilibrium diagram various phases i. Critical temperatures and significance ii. Reactions on Iron carbon equilibrium diagram 2.3 Broad Classification of steels. i. Plain carbon steels: Definition, Types and Properties, Compositions and applications of low, medium and high carbon steels. ii. Alloy Steels: Definition and Effects of alloying elements on properties of alloy steels. iii. Tool steels Cold work tool steels, Hot work tool steels, High speed steels(HSS) iv. Stainless Steels: Types and Applications v. Spring Steels: Composition and Applications vi. Specifications of steels and their equivalents 2.4 Steels for following: Shafts, axles, Nuts, bolts, Levers, crank shafts, camshafts, Shear blades, agricultural equipments, house hold utensils, machine tool beds, car bodies, Antifriction bearings and gears.
Unit- III	3a. Select the relevant cast	3.1 Types of cast irons as white, gray,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Cast Iron	iron for the given job with justification. 3b. Interpret the given material designations. 3c. Identify the properties of the given composition of cast iron with justification.	nodular, malleable 3.2 Specifications of cast Iron. 3.3 Selection of appropriate cast iron for engineering applications. 3.4 Designation and coding (as per BIS, ASME, EN, DIN, JIS) of cast iron, plain and alloy steel.
Unit– IV Non-ferrous Metals and alloys	4a. Describe the properties and applications of the given copper alloy. 4b. Describe the properties and applications of the given aluminium alloy. 4c. Describe the properties and applications of the given bearing material 4d. Select relevant non-ferrous material for the specified application with justification.	4.1 Copper and its alloys - brasses, bronzes Chemical compositions, properties and Applications. 4.2 Aluminium alloys –Y-alloy, Hindalium, duralium with their composition and Applications. 4.3 Bearing materials like white metals (Sn based), aluminium bronzes Porous, Self lubricating bearings.
Unit– V Non-metallic and Advanced Materials	5a. Distinguish between metallic and nonmetallic materials on the basis of given composition, properties and applications. 5b. Select relevant non-metallic material for the given job with justification. 5c. Select relevant composite material for the given job with justification. 5d. Suggest relevant alternative materials for the given job with justification.	5.1 Polymeric Materials i. Polymers- types, characteristics. ii Properties and uses of Thermoplastics. Thermosetting Plastics and Rubbers. 5.2 Thermoplastic and Thermosetting Plastic materials 5.3 Characteristics and uses of ABS, Acrylics, Nylons and Vinyls,Epoxides, Melamines and Bakelites 5.4 Rubbers Neoprene, Butadiene, Buna and Silicons – Properties and applications. 5.5 Ceramics –types of ceramics, properties and applications of glasses and refractories 5.6 Composite Materials - properties and applications of Laminated and Fibre reinforced materials 5.7 Advanced Engineering Materials - Properties and applications of Nano materials and smart materials.
Unit– VI Heat Trentment processes	6a. Describe with sketches the specified heat treatment processes. 6b. Select the relevant heat treatment process for the	6.1 Annealing: Purposes of annealing, Annealing temperature range, Types and applications Normalizing: Purposes of Normalizing, Temperature range, Broad applications of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given material with justification 6c. Explain with sketches the working principle of the given heat treatment furnace 6d. Suggest the relevant heat treatment process for the given situation with justification.	Normalizing 6.3 Hardening: Purposes of hardening, Hardening temperature range ,application 6.4 Tempering: Purpose of tempering, Types of tempering and its applications 6.5 Case hardening methods like Carburizing, Nitriding, and Cyaniding. 6.6 Heat treatment Furnaces – Muffle , Box type

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
I	Basics of Engineering Materials	06	02	04	04	10
II	Steel and its alloys	10	04	04	06	14
III	Cast Iron	08	02	04	04	10
IV	Non ferrous Metal and Alloys	08	02	04	02	10
V	Non Metallic and advanced Material	08	04	04	04	12
VI	Heat Treatment processes	08	04	06	04	14
Total		**48**	**18**	**26**	**26**	**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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews

a. Prepare journal based on practical performed in Material Testing laboratory .Journal consist of drawing, observations , required materials, tools, equipments, date of performance with teacher signature.
b. Prepare/Download a specifications of followings:
    i. Tools and equipment in material testing laboratory.
    ii. Machineries in material testing laboratory
a. Undertake a market survey of local dealers for tools, equipments; machineries and raw material prepare a report.
b. Visit any Industrial heat treatment shop and prepare report consisting

i. Types of heat treatment process
ii. Types of furnaces
iii. Types of quenching mediums used
iv. Types of Testing equipments
v. Safety precautions observed.

c. Guide student(s) in undertaking micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various 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.
f. Arrange visit to nearby industries for understanding various Heat treatment processes.
g. Show video/animation films to explain functioning of various hardness testing and heat treatment processes.
h. Draw Iron Carbon charts.
i. Use different instructional strategies in classroom teaching.

12. SUGGESTED TITLES OF MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably 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. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. 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. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. **Comparative study**: Comparative study of various materials used in previous and current generation components of mechanical engineering equipments like IC Engine, Compressor, turbine, pumps, refrigerator, water cooler, Lathe Machine, Milling Machine, Drilling Machine grinding machine (any one) with proper justifications.
b. **Experimentation:** Determine the hardness of different metallic components (min.5) and compare hardness and plot a bar chart indicating hardest and soft material in the given group

c. **Experimentation:** Determine the microstructure of different metallic components (min.5) using metallurgical Microscope and compare their microstructure in the given group
d. **Collection:** Collect sample of various types of plastics, ceramics, composites used in day to day applications and prepare chart containing properties, applications of the samples.
e. Collect information related to Types, Properties and applications of smart materials from websites. Present the information in the form of Chart.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Engineering Material	Sharma, C. P.	PHI Learning, New Delhi 2015 ISBN 978-81-203-2448-0
2.	Engineering Materials	Agrawal, B. K.	McGraw Hill Education, New Delhi ISDN 978-00-745-1505-1
3.	Material Science and metallurgy	Kotgire, V. D.	Everest publishing House, New Delhi 2015; ISBN 81 86314 008
4.	Material Science and metallurgy	Khanna, O. P.	Dhanpat Rai and sons. New Delhi 2015; ISBN- 978-81-899-2831-5
5	Material Science for Polytechnic	Rajput, R. K.	S K Kataiya and sons; New Delhi 2015; ISBN- 81-85749-10-8

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://vimeo.com/32224002
b. http://www.substech.com/dokuwiki/doku.php?id=iron-carbon_phase_diagram
c. http://www-g eng.cam.ac.uk/mmg/teaching/typd/
d. http://www.ironcarbondiagram.com/
e. http://www.youtube.com/watch?v=1H10bOfj3T0andfeature=related
f. http://www.youtube.com/watch?v=eN5YH0iEvTo
g. http://www.youtube.com/watch?v=m9l1tVXyFp8
h. http://www.studyvilla.com/electrochem.aspx
i. http://www.sakshat.ac.in/

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

TEACHING AND EXAMINATION SCHEME FOR POST S.S.C. DIPLOMA COURSES

COURSE NAME : DIPLOMA IN MECHANICAL ENGINEERING

COURSE CODE : ME

DURATION OF COURSE : 6 SEMESTERS **WITH EFFECT FROM 2012-13**

SEMESTER : FIFTH **DURATION : 16 WEEKS**

PATTERN : FULL TIME - SEMESTER **SCHEME : G**

SR. NO	SUBJECT TITLE	Abbre viation	SUB CODE	TEACHING SCHEME			EXAMINATION SCHEME								SW (17500)
							PAPER HRS.	TH (1)		PR (4)		OR (8)		TW (9)	
				TH	TU	PR		Max	Min	Max	Min	Max	Min	Max	Min
1	Automobile Engineering	AEN	17526	03	--	02	03	100	40	--	--	--	--	25@	10	
2	Advanced Manufacturing Processes β	AMP	17527	03	--	02	03	100	40	--	--	--	--	25@	10	
3	Measurement & Control β	MAC	17528	03	--	02	03	100	40	--	--	--	--	25@	10	
4	Power Engineering	PEN	17529	03	--	02	03	100	40	25#	10	--	--	25@	10	**50**
5	Metrology and Quality Control β	MQC	17530	03	--	02	03	100	40	25#	10	--	--	25@	10	
6	Behavioural Science $	BSC	17075	01	--	02	--	--	--	--	--	25#	10	25@	10	
7	CNC Machines β	CNC	17064	01	--	02	--	--	--	50#	20	--	--	25@	10	
8	Professional Practices-III β	PPT	17065	--	--	03	--	--	--	--	--	--	--	50@	20	
	TOTAL			**17**	**--**	**17**	**--**	**500**	**--**	**100**	**--**	**25**	**--**	**225**	**--**	**50**

Student Contact Hours Per Week: **34 Hrs.**

THEORY AND PRACTICAL PERIODS OF 60 MINUTES EACH.

Total Marks **: 900**

@ - Internal Assessment, # - External Assessment, [ ] No Theory Examination, $ - Common to all branches, #* - Online Examination,
β - Common to AE, PG, PT

Abbreviations: TH-Theory, TU- Tutorial, PR-Practical, OR-Oral, TW- Term Work, SW- Sessional Work

- Conduct two class tests each of 25 marks for each theory subject. Sum of the total test marks of all subjects is to be converted out of 50 marks as sessional work (SW).
- Progressive evaluation is to be done by subject teacher as per the prevailing curriculum implementation and assessment norms.
- Code number for TH, PR, OR, TW are to be given as suffix 1, 4, 8, 9 respectively to the subject code.

Course Name : Diploma in Mechanical Engineering

Course Code : ME/MH/MI

Semester : Fifth for ME and Sixth for MH,MI

Subject Title : Automobile Engineering

Subject Code : 17526

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

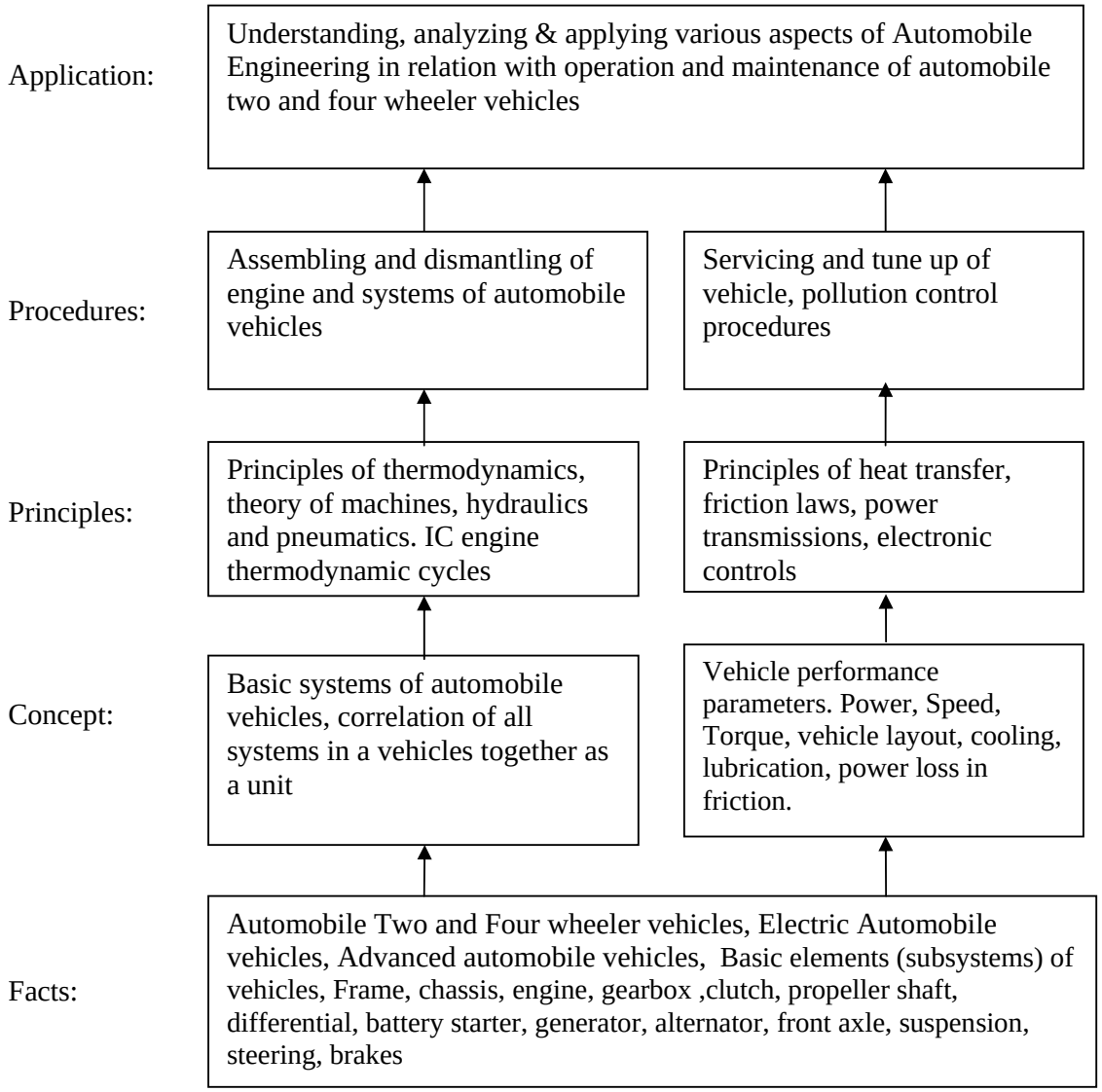
Automobile vehicles a now days are the inseparable part of modern life. The whole progress of the world is based on the development of modern automobiles. The diploma engineers must know about the principles of working, construction, maintenance of automobiles. Different types of vehicles and their capacities are introduced in this course so as to give idea about field of scope. Various automobile systems such as engine transmission, cooling and lubrication, vehicle control, etc. are introduced along with their functions, construction and working in the context of vehicle performance. The two wheelers have undergone a phenomenal technological progress. The topic of two wheeler technology is also covered in course. Good knowledge of automobile engineering will lead to better employability of engineering students.

General Objectives:

Students will be able to:

1. Know about Automobile market in India.
2. Know the vehicles performance parameters.
3. Understand the detailed construction features of automobile engines.
4. Dismantle and assemble the automobile engines and vehicle systems.
5. Know various advanced features in modern automobile vehicles.
6. Understand and identify various system components with their functions.
7. Compare and select the automobile vehicles based on their features.

Learning Structure:



Theory:

Topics and Contents	Hours	Marks
1. Introduction to Automobiles. Specific objectives**:** ➢ Draw the vehicle layouts ➢ Understand the concept of aerodynamic shape of vehicle. ➢ State the concept of aerodynamic aspects Contents: 1.1 Classification of automobile vehicles, types of automobile vehicles. ➢ Two and four wheeler chassis layout of an automobile vehicle, automobile body types, ➢ Layout of vehicle such as front engine rear wheel drive, front engine front wheel drive, rear engine rear wheel drive, four wheels drive etc. their advantages, comparisons. ➢ Aerodynamic body shapes & advantages 1.2 Types of automobile power plants such as petrol engine, diesel engine, gas operated (LPG, CNG),electric power plants, hybrid power Plants (Intorductionary level).	08	16
2. Transmission Systems: Specific Objectives: ➢ Describe transmission system of automobiles and their components ➢ Describe suspension systems and components Content: 2.1 **Need and Requirements of transmission system. Its components and their functions**. 2.2 **Clutch**: Function and purpose of clutch, types and construction of clutches as coil spring type and diaphragm type 2.3 **Gear box**- constant mesh and synchromesh gear boxes, Epicyclic gear box their construction and operation. Overdrive, transfer case, Two wheeler gear box construction and operation 2.4 **Propeller shaft** types and construction, functions of universal and slip joints. 2.5 **Differential** - need, construction and working, differential action and operation 2.6 **Axle** – Hotchkiss and torque tube drives,Rear- full floating axle, semi floating and three quarter floating axle.Front axle.	10	20
3. Control Systems: **Specific objectives:** ➢ State steering geometry and requirements ➢ Describe Braking system of automobiles. Content: 3.1 **Steering System:** 08 Marks Purpose of steering system, construction and working of - recirculating ball type and rack and pinion. Wheel Geometry- caster, camber, king pin inclination, Toe In and Toe Out. Power steering (introductory). 3.2 **Braking System:** 10 Marks Need of braking system, types of automotive braking systems for two and four wheeler vehicles – mechanical, hydraulic and air operated	08	18

➢ Hydraulic braking systems: Layout & components of hydraulic braking systems ➢ Construction and working of master cylinder and wheel cylinder. ➢ Drum braking system, Disc Braking Systems ➢ Air braking system**:** layout and working		
4. Suspension Systems, Wheels and Tyres 4.1 **Necessity and Classification of Suspension System** 10 Marks Front and rear suspension system construction and working of Wishbone type, Mac Pherson type, Trailing link type, coiled springs, leaf spring and shock absorbers, air suspension system. 4.2 **Wheels and Tyres** 08 Marks types of wheel-spoked,disc, light alloy cast. Types of rims. Tyres-Desirable properties, types-redial ply, cross ply, tubeless.Tyre specifications. Factors affecting tyre life. Wheel alignment and balancing.	08	18
5. Electrical Systems: **Specific Objectives:** ➢ Sketch and describe battery constructional details ➢ Describe charging system ➢ Describe starting system and lighting system **Content:** 5.1 **Battery:** 08 Marks Automotive battery construction and operation, battery capacity, Battery ratings, Battery tests Charging System : Need of charging system, Construction and operation of charging system, Alternator principle ,construction and working 5.2 **Starting System :** 04 Marks Need of starting system, layout, construction of starting motor, Bendix drive 5.3 **Lighting System :** 04 Marks Layout of lighting system of two wheeler and four wheeler, Wiring harness, cable color codlings 5.4 **Ignition System and their Components** 04 Marks Battery, magneto, electronic inginition system.	10	20
6. Automobile Air conditioning System. **Specific Objectives:** ➢ Understand concept of air conditioning system ➢ Appreciate the various parameters of aircontioning ➢ Locate various components of air conditioning systems in a vehicle Introduction, layout of car air conditioning system, components of a system, working of a system, parameter control (Humidity, temperature, purity of air) required. Important precautions while using AC system.	04	08
Total	**48**	**100**

Practical:
Skills to be developed:
Intellectual Skills:

1. Locate and identify layout of automobile vehicles.
2. Locate and identify different components of various systems of automobile vehicles.
3. Understand basic engine construction in detail.

4. Refer and interpret Service manuals, Specification charts of automobile vehicles.

Motor Skills:

1. Use proper hand tools, equipments in automobile maintenance
2. Assemble and dismantle petrol and diesel engines of car
3. Assemble and dismantle automobile systems.
4. Conduct PUC test on automobile vehicles.
5. Collect and interpret technical specifications of two and four wheeler automobiles from market and internet.

List of practical:
(Conduct any ten experiments of the following.)

1. Individual student should collect following information-
   (a) Automobile manufacturers in India-Two or four wheeler vehicles.
   (b) Advance systems in automobiles like ABS, Safety Air Bag,power operated-mirror/window etc.
2. Observe the chasis of following vehicle like LCV or HCV or Jeep. Draw and describe various components mounted on it.
3. Dismantle and assemble single plate-coil and diaphragm type clutch. List the various tools used while dismantling.
4. Dismantle and assemble synchromesh gear box. Prepare sequence chart while assembling.
5. Dismantle and assemble differential. Prepare sequence chart while assembling.
6. Observe various steering systems of automobile vehicle and make a systematic record.
7. Dismantle brake system and observe various components of it. Write function of important components.
8. Observe and draw various suspension systems with brief description.
9. Visit to automobile service centre, observe various systems and write a report.
10. Inspection of battery like Ah rating, type of battery, no. of cells, vents, charge status by using hydrometer and voltmeter.
11. Conduct PUC test of car on exhaust gas analyzer according to Indian Motor Vehicle act 1989 revised norms (Petrol or diesel) and write a report.
12. Visit to car air-conditioning service centre and prepare report on maintenance.

Learning Resourses:

1. **Books:**

Sr. No.	Author	Title	Publisher/Edition
1.	Wiliam Crouse	Automobile Engineering	Tata- McGraw Hill 2009
2	K.K.Jain, R.B.Asthana	Automobile Engineering	Tata- McGraw Hill 2011
3.	H.M.Sethi	Automobile Engineering	Tata- McGraw Hill 2010
4	Shrinivasan	Automobile Engineering	Tata- McGraw Hill 2009
5	Kirpal singh	Automobile Engineering	Standard Publications 2009
6	Joseph heitner	Automotive Mechanics	Wiley 2002

1. Central Motor Vehicle Act Pollution Norms, Service Manuals for different Cars, Motor cycles, Trucks, Technical literature on specifications of different vehicles, Manuals of Exhaust gas analysers, Euro III, Euro IV norms for cars, trucks

2. CDs, PPTs, Video Clips: On various constructional and operational details of working of different automobile systems based on internet web sites as under,
    - www.tatamotors.com
    - www.hyundai.co.in
    - www.india.ford.com
    - www.marutisuzuki.com
    - www.auto.howstuffworks.
    - You tube videos for automobile systems

3. Charts, Models, Transparencies on automobile systems and components.

Course Name : Mechanical Engineering Group

Course Code : ME/MH/MI/PG/PT/FE/FG

Semester : Fifth for ME/PG/PT/FG and Sixth for MH/MI/FE

Subject Title : Advanced Manufacturing Processes

Subject Code : 17527

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

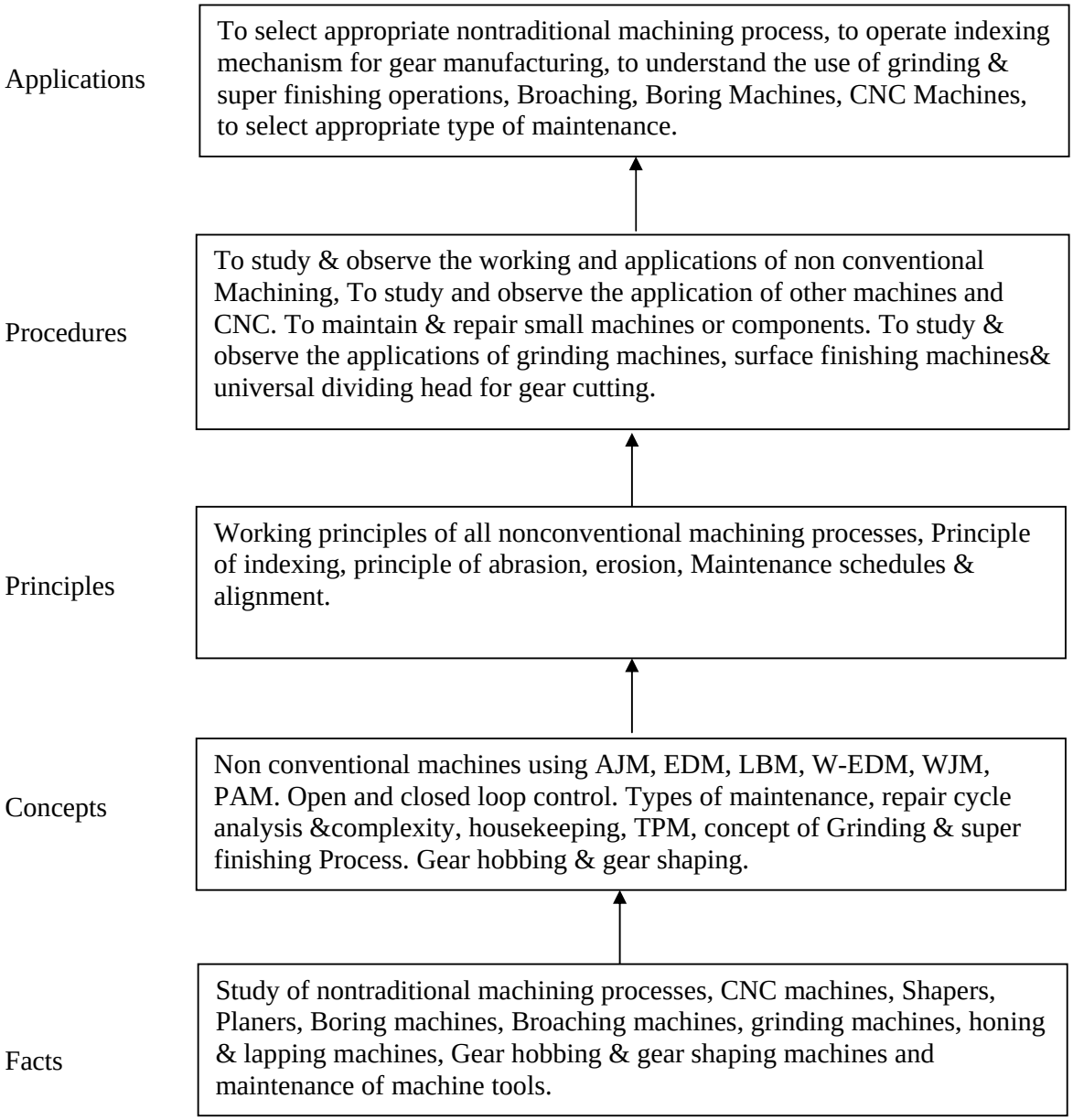
This is a advanced technology subject which is to be taught, after getting conversant with the basic manufacturing processes. It is necessary for a diploma engineer to know about the advancements in the area of manufacturing processes. This subject will impart knowledge & skills necessary for working in modern manufacturing environment. This subject will help the student to get familiarize with working principles and operations performed on non conventional machines, CNC Machines, milling machines, grinding machines, surface finishing machines and maintenance of machine tools.

Objectives:

The student will be able to:

1) Know different Nontraditional machining processes.
2) Understand the working of Broaching Machine, Milling Machine, Gear Cutting machines, Grinding Machines, Surface finishing machines.
3) Work as a maintenance engineer.
4) Know the Operation and control of different CNC machine tools.
5) Produce jobs as per specified requirements by selecting the specific machining process.
6) Adopt safety practices while working on various machines.
7) Develop the mindset for modern trends in manufacturing and automation.

Learning Structure:



Theory:

Topic & Content	Hours	Marks
Topic 1. Non Traditional Machining **Specific Objectives** ➢ Understand different Nontraditional machining processes. **Content** 1.1 Need and importance, classification 04 Marks 1.2 AJM, WJM, EDM, W-EDM - setup, working, process parameters, advantages, disadvantages and applications. 08 Marks 1.3 PAM, LBM - setup, working, process parameters, advantages, disadvantages and applications. 08 Marks	10	20
Topic 2: Introduction to CNC **Specific Objectives** ➢ Know the Operation and control of CNC machine tools. **Content** 2.1 Introduction, advantages of CNC, open loop and closed loop control, axis identification, absolute & incremental coordinate system- G codes and M codes 08 Marks 2.2 Fundamental part programming - simple lathe and milling programmes. Dry run, Jog Mode, Block by Block execution, Safety Procedures, Adaptive controls, Displays and indicators. 08 Marks	08	16
Topic 3: Other Machining Methods **Specific Objectives** ➢ Understand the working of different Machines. **Content** 3.1 Introduction, classification of Broaching machines, basic parts of horizontal broaching machine & their functions, applications, advantages and limitations of Broaching machine. 08 Marks 3.2 Capstan, turret lathe & automats, Planer and planomiller function of parts & operations. 04 Marks 3.3 Boring Machines – types, tools and operations. 04Marks	08	16
Topic 4: Milling & Gear Cutting **Specific Objectives** ➢ Understand the working of Milling & Gear Cutting machines. **Content** 4.1 **Milling:** 10 Marks Introduction, classification ,basic parts of column & knee type milling machine & their functions, standard milling cutters, milling operations like plain milling, side milling, straddle milling, gang milling, face milling - slot milling, slitting. Up milling & down milling, cutting parameters. 4.2 **Gear Cutting:** 12 Marks Introduction, gear manufacturing methods, universal dividing head & indexing methods, gear shaping & gear hobbing - setup, working, advantages, disadvantages, applications, gear finishing methods-grinding, shaving, burnishing.	10	22
Topic 5. Surface Finishing **Specific Objectives** ➢ Understand the working of Grinding Machines & Surface finishing machines.	06	14

Content 5.1**Grinding Machines** 08 Marks Classification and working of grinding machine - surface, cylindrical, centreless, grinding wheel specifications, grinding wheel dressing & truing. Selection criteria for grinding wheel. Balancing of grinding wheels, safety precautions. 5.2 **Super Finishing** 06 Marks Methods of surface finishing like honing, lapping, burnishing, polishing and buffing - setup, working, advantages, limitations and applications.		
Topic 6. Maintenance of Machine Tools: **Specific Objectives** ➢ Know the maintenance methods and procedures. **Content** Need and importance of maintenance activity, Types of maintenance, Basic maintenance practices for simple machine elements, viz Bearing, Coupling, Shaft and pulley , gears, chains, machine belts. Repair cycle analysis, Repair complexity, Maintenance manual, Maintenance records.	06	12
Total	**48**	**100**

Practical:

Skills to be developed:

Intellectual Skills:

1) Compare an appropriate non conventional machining process for required component.
2) Write part programming for a component.
3) Know the significance of various super finishing methods.
4) Calculations for indexing for a spur gear cutting, helical gear cutting.
5) Select the grinding machine parameters.
6) Identify the maintenance procedure for a machine.

Motor Skills:

1) Use the indexing mechanism.
2) Operate CNC Lathe & CNC milling machine.
3) Operate grinding machine
4) Carry out maintenance of machines.
5) Use and operate different hand tools required for repair and maintenance.
6) Identify and rectify the faults in the given sub assembly.

List of Practical:

1) Industrial visit to observe at least one nontraditional machining process and write a report individually on visit.
2) One simple Job on CNC Lathe Machine and Verification on simulation software (One job /max. four students).
3) One simple Job on CNC Milling Machine and Verification on simulation software (One job /max. four students)
4) Industrial visit to observe Broaching machine, Boring machine, Planer machine and report on the same.
5) One job of gear cutting (spur gear /helical gear) by using simple indexing method (max. four students per job).
6) One job containing surface grinding / cylindrical grinding operation. (max. four students per job).

7) Industrial visit to observe at least one super finishing process.
8) Maintenance procedure for any two machines/machine elements with reference to type of faults, causes & remedies. (In a group of 4-5 students)
9) Teacher can suggest topics (ind. visit/non conv. man. process etc.) for ppt files and students (4 students) should present in practical batch.

Notes:
1. The workshop instructor should prepare the specimen job in each shop as demonstration/ before the students (as per the drawing given by subject teacher / workshop superintendent)
2. Theory behind practical is to be covered by the concerned subject teacher / workshop superintendent.
3. Workshop diary should be maintained by each student duly signed by respective shop instructors

Sr. No.	Equipment /Software	Group Size	Remark
1	Simulation software for Turning on 20 PCs	One student	Institute can establish a separate simulation, CAD, CAM, CAE, computational facility lab. Internet facility is must. Teacher can download good videos and help students to understand the principles. Students can observe various videos on machining, calibration, maintenance of machine tools.
2	Simulation software for Milling on 20 PCs		
3	Videos demonstrating Non Conventional machining and other machines on 20 PCs		
4	Simulation software for Grinding on 20 PCs		
5	Videos on maintenance of machine tools		

Learning Resources:
Books:

Sr.No.	Author	Title	Publisher
01	S. K. Hajra Chaudary, Bose, Roy	Elements of workshop Technology-Volume II	Media Promoters and Publishers Limited
02	O. P. Khanna & Lal	Production Technology Volume- II	Dhanpat Rai Publications.
03	P.K.Mishra	Nonconventional Machining	Narosa Publishing Houswe
04	H.P.Garg	Industrial Maintenance	S.Chand& Co.
05	L.R.Higgins	Maintenance Engg. Handbook	McGraw Hill
06	B. L. Juneja, G.S.Sekhon, Nitin Seth	Fundamental of metal cutting and machine tools	New age international ltd.
07	P.C.Sharma	Production Engg.	Dhanpat Rai Publications.
08	S.F.Krar,A.R.Gill,P.Smid	Technology of Machine Tools	Tata-McGraw Hill
09	HMT	Production Technology	Tata-McGraw Hill
10	B.S.Pabla &M.Adithan	CNC Machines	New Age International Ltd.

Course Name : Mechanical Engineering Group

Course code : ME/MH/MI/PG/PT

Semester : Fifth for ME/PG/PT and Sixth for MH/MI

Subject Title : Measurements and Control

Subject Code : 17528

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

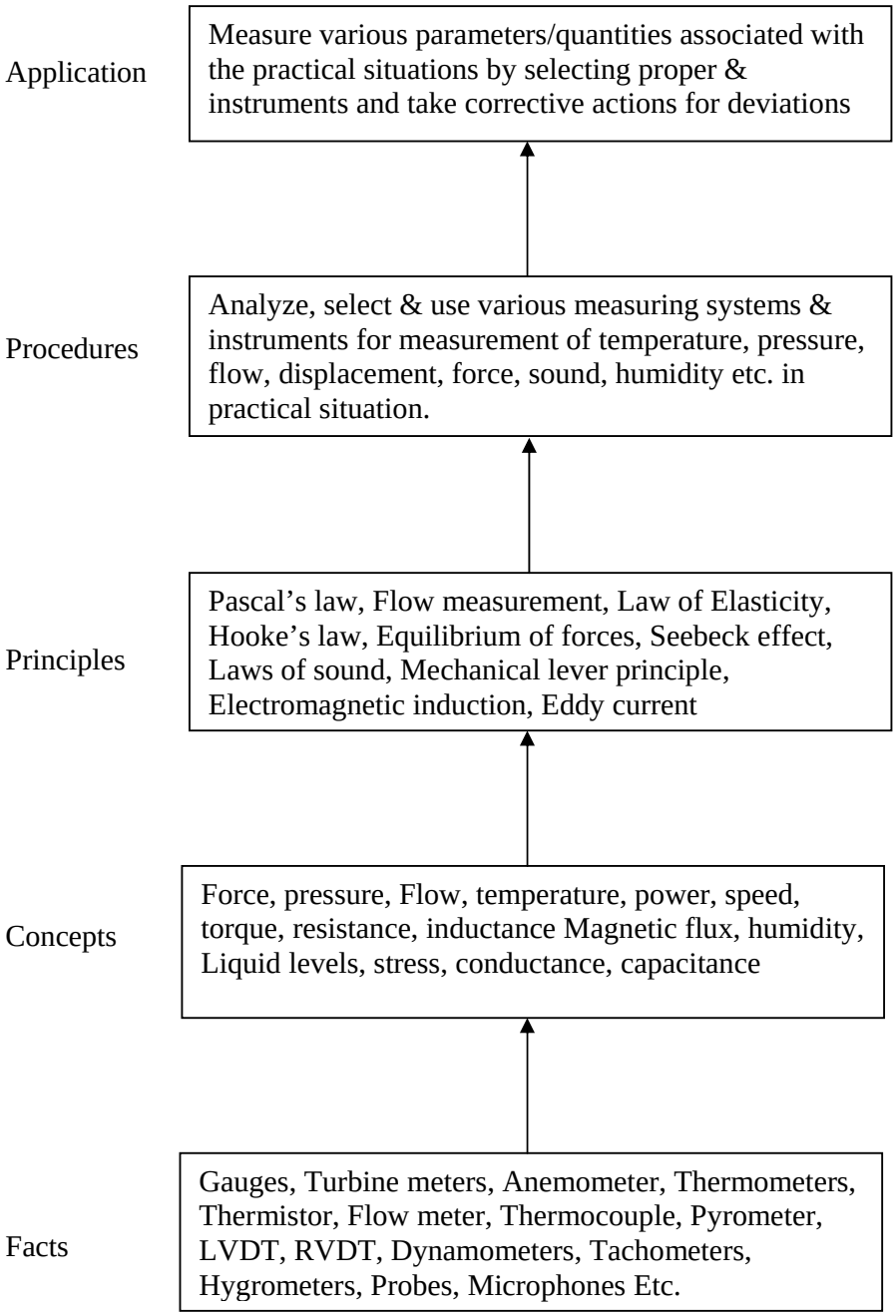
The art of measurement plays an important role in all branches of engineering. With advances in technology, measurement techniques have also taken rapid strides, with many types of instrumentation devices, innovations, refinements. The course aims at making a Mechanical Engineering student familiar with the principles of instrumentation, transducers & measurement of non electrical parameters like temperature, pressure, flow, speed, force and stress and methods of control systems for engineering applications.

Objectives:

Student will be able to:

1. Understand the principle of operation of an instrument.
2. Appreciate the concept of calibration of an instrument.
3. Select Suitable measuring device for a particular application.
4. Identify different types of errors.

Learning Structure:



Contents: Theory

Topic and content	Hours	Marks
1: Introduction and significance of Measurement **Specific objectives**- The students will be able to understand ➢ Terminology related to measurement ➢ Various types of errors ➢ Concept of transducers **Contents:** 1.1 **Types of measurement, classification of instruments** **Static terms and characteristics**- Range and Span, Accuracy and Precision, Reliability, Calibration, Hysteresis and Dead zone, Drift, Sensitivity, Threshold and Resolution, Repeatability and Reproducibility, Linearity. **Dynamic characteristics**- Speed of response, Fidelity and Dynamic errors, Overshoot**.** **06 Marks** 1.2 **Measurement of error**- Classification of errors, environmental errors, signal transmission errors, observation errors, operational errors. 04 Marks 1.3 **Transducers :** Classification of transducers, active and passive, resistive, inductive, capacitive, piezo-resistive, thermo resistive 08 Marks	08	18
2: Displacement and Pressure Measurement **Specific objectives-** The students will be able to ➢ Explain working of displacement transducers ➢ Explain construction and working of low pressure and high pressure measuring instruments. **Contents:** 2.1 **Displacement Measurement** Capacitive transducer, Potentiometer, LVDT, RVDT, Specification, selection & application of displacement transducer. Optical measurement scale and encoders 08 Marks 2.2 **Pressure Measurement** Low pressure gauges- McLeod Gauge, Thermal conductivity gauge, Ionization gauge, Thermocouple vacuum gauge, Pirani gauge. High Pressure gauge-Diaphragm, Bellows, Bourdon tube, Electrical resistance type, Photoelectric pressure transducers, piezoelectric type, Variable capacitor type 10 Marks	10	18
3: Temperature Measurement **Specific objectives** The students will be able to ➢ Explain electrical and non electrical methods of temperature measurements ➢ Describe high temperature measuring instruments such as pyrometers **Content:** 3.1 **Non-electrical methods**- Bimetal , Liquid in glass thermometer and Pressure thermometer 04 Marks 3.2 **Electrical methods**- RTD, Platinum resistance thermometer, Thermistor, Thermoelectric methods - elements of thermocouple, Seebek series, law of	06	16

intermediate temperature, law of intermediate metals, thermo emf measurement. 08 Marks 3.3 Pyrometers- radiation and optical 04 Marks		
4: Flow Measurements **Specific objectives-** The students will be able to ➢ Describe variable area, variable velocity flow meters ➢ Special flow meters-electro-magnetic and ultrasonic flow meter **Content :** 4.1 **Variable area meter**-Rota meter, Variable velocity meter-Anemometer **06 Marks** 4.2 **Special flow meter**- Hot wire anemometer, Electromagnetic flow meter, Ultrasonic flow meter ,Turbine meter ,Vortex shedding flow meter **06 Marks**	06	12
5: Miscellaneous Measurement **Specific objectives-** **The students will be able to** ➢ Explain characteristic of sound and Measurement of sound intensity ➢ Measure shaft power ➢ Describe contact and non contact type of speed measuring instruments ➢ Explain working of strain gauges **Content** : 5.1 Introduction to sound measurement and study of Electro dynamic microphone and Carbon microphone. 5.2 **Humidity measurement** –Hair hygrometer, Sling psychrometer, 5.3 **Liquid level measurement** – direct and indirect methods. 5.4 **Force & Shaft power measurement** -Tool Dynamometer (Mechanical Type), Eddy Current Dynamometer, Strain Gauge Transmission Dynamometer. 5.5 **Speed measurement** -Eddy current generation type tachometer, incremental and absolute type, Mechanical Tachometers, Revolution counter & timer, Slipping Clutch Tachometer, Electrical Tachometers, Contact less Electrical tachometer, Inductive Pick Up, Capacitive Pick Up, Stroboscope 5.6 **Strain Measurement**-Stress-strain relation, types of strain gauges, strain gauge materials, resistance strain gauge- bonded and unbounded, types(foil, semiconductor, wire wound gauges), selection and installation of strain gauges load cells, rosettes.	08	16

6 : Control Systems **Specific objectives-** The students will be able to ➢ Know various types of control systems and their comparison ➢ State field applications of control systems **Contents:** 6.1 Block diagram of automatic control system, closed loop system, open loop system, feed back control system, feed forward control system, servomotor mechanism, 06 Marks 6.2 Comparison of hydraulic, pneumatic, electronic control systems, 06 Marks 6.3 Control action: Proportional, Integral, derivative, PI, PD, PID 04 Marks 6.4 Applications of measurements and control for setup for boilers, air conditioners, motor speed control 04 Marks	10	20
Total	**48**	**100**

Note- Numerical based on chapter 1,4,5 only

Practical:
Skills to be developed:

Intellectual Skills:
1. Analyze the result of calibration of thermister
2. Interpret calibration curve of a rotameter
3. Evaluate the stress induced in a strain gauge
4. Verify the characteristics of photo transister and photo diode

Motor Skills:
1. Test and calibration of a thermocouple
2. Handle various instruments
3. Draw the calibration curves of rotameter and thermister
4. Measure various parameters using instruments

List of Practical:
1 Understand the methods of measurements and instrument characteristics with demonstration of any one measuring device.
2 Displacement measurement by inductive transducer (LVDT)
3 Measurement of negative pressure using McLeod gauge / Bourdon tube pressure gauge. Conversion of pressure in different units.
4 Measurement of temperature by using Thermocouple.
5 Measurement of flow by using rotameter.
6 Measurement of strain by using a basic strain gauge and verify the stress induced.
7 Speed Measurement by using Stroboscope / Magnetic / Inductive Pick Up.
8 Measurement of force & weight by using a load cell.
9 Liquid Level Measurement by using Capacitive Transducer system.
10 Study of control system with one suitable application (boiler) arranging industrial visit at sugar factory / paper mill / textiles / food processing industry.
11 Mini project-A group of 4 students shall take a mini project of searching information about advanced instrumentation / control system using internet and submit its report. Use of this knowledge in project (6^{th} Sem) is highly appreciable.

12 Visit various departments/laboratories in own institute and understand how the measurement devices are fitted on machines/equipments, the procedure of measurement and calibration. (viz. Applied mechanics/ Electronics/ Instrumentation dept.)

Learning Resources:
Books:

Sr. No.	Author	Title	Publication
01	D.S.Kumar	Mechanical Measurements & Control	Metropolitan Publications, New Delhi
02	R.K.Jain	Mechanical & Industrial Measurements	Khanna Publications, New Delhi
03	A.K.Sawhney	Mechanical Measurements & Instrumentation	Dhanpat Rai & Sons, New Delhi.
04	E. O. Doebelin	Measurement Systems	Tata McGraw Hill Publications
05	R.V. Jalgaonkar	Mechanical Measurement & Control	Everest Publishing House, Pune
06	C.S. Narang	Instrumentation Devices & Systems	Tata McGraw Hill Publications
07	B. C. Nakra and K.K.Chaudhary	Instrumentation, Measurement and Analysis	Tata McGraw Hill Publication
08	Thomas Beckwith	Mechanical Measurement	Pearson Education
09	James W Dally	Instrumentation for Engg. Measurement	Wiley India

Course Name : Mechanical Engineering Group

Course code : ME/MH/MI

Semester : Fifth for ME and Sixth for MH/MI

Subject Title : Power Engineering

Subject Code : 17529

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
03	--	02	03	100	25#	--	25@	150

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

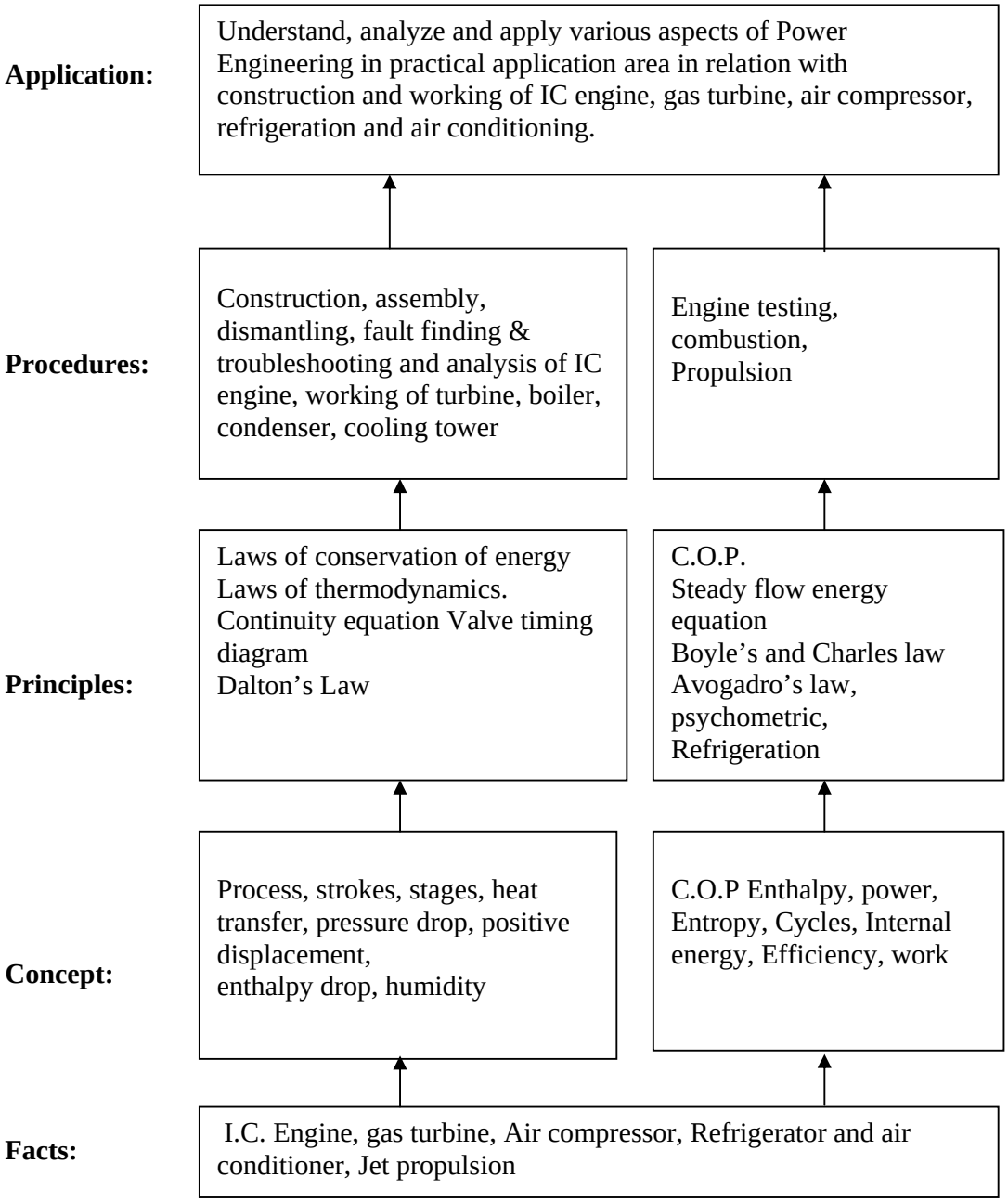
I.C.Engines find applications in almost all sectors of industry and in automobiles. Diploma technicians deal with working, testing and maintenance of I.C. Engines. I.C. Engines are one of the major contributors of air pollution. Hence I.C. Engine pollution control plays a vital role in protecting the environment. Use of air compressors is increasing due to automation. Hence it is necessary to understand constructional features and thermodynamic aspect of air compressor. Gas turbine is used for power generation and for jet propulsion. Diploma engineer should understand the fundamentals of refrigeration and air- conditioning as there are many industrial applications and also many entrepreneual opportunities in this field.

General Objectives:

The Student will be able to:

1. Describe construction and working of I. C. Engines.
2. Calculate various performance parameters by conducting trial on I. C. Engines.
3. Explain working and applications of gas turbines.
4. Explain different types of air compressors and conduct trial on air Compressor.
5. Describe construction, working and application of vapor compression cycle.
6. Appreciate psychometric processes and air conditioning systems.

Learning Structure:



Theory:
Theory:

Topic and content	Hrs.	Marks
1. I.C. Engine **Specific Objectives** ➢ Draw air standard cycles. ➢ Explain the combustion and ignition method of I. C. Engine. 1.1 Power Cycles • Carnot, Otto, Diesel, Dual, Brayton Cycle, representation on P-V, T-S diagram and Simple numerical on Otto cycle &Carnot cycle. 1.2 Classification and Application of I. C. Engines. • Four stroke Engines, Construction and working, valve timing Diagram, Turning moment diagram • Brief description of I.C. Engine combustion (SI & CI), scavenging, preignition, detonation, supercharging, turbo charging, air fuel ratio requirements, M.P.F.I., Types of sensors, fuel injection pump, battery ignition in SI Engines	10	20
2. I.C. Engine Testing and Pollution Control **Specific Objectives:** ➢ List lubricant and additive ➢ State the pollutants and their effect ➢ Calculate various efficiencies 2.1 Engine terminology: Stroke, bore, piston speed, MEP, compression & cut-off ratio. Engine Testing - I.P., B.P. Mechanical, Thermal, relative efficiency and, BSFC, Heat Balance sheet. Morse Test, Motoring test ---- 10 Marks 2.2 List of fuel, lubricant additives and their advantages. ---- 04 Marks 2.3 Pollution Control ---- 10 Marks Pollutants in exhaust gases of petrol and diesel engines, their effects on environment, exhaust gas analysis for petrol and diesel engine, Catalytic Converter, Bharat stage III, IV norms.	10	24
3. Air Compressor **Specific Objectives** ➢ Explain the concept of single and multistage compressor. ➢ List the methods of energy saving. 3.1 Introduction Uses of compressed air, Classification of air compressors, Definitions of Pressure ratio, Compressor capacity, Free Air Delivered, Swept volume. 3.2 Reciprocating Air Compressor ---- 10 Marks Construction and working of single stage and two stage compressor Efficiency: Volumetric , Isothermal and Mechanical Advantages of multi staging, Intercooling and after cooling. 3.3 Rotary Compressor ----- 10 Marks Construction and working of screw, lobe, vane, (No Numericals) Comparison and applications of reciprocating and rotary compressors Purification of air to remove oil, moisture and dust, Methods of energy saving in air compressors.	10	20
4. Gas Turbine And Jet Propulsion **Specific Objectives** ➢ Classify gas turbines. ➢ Describe method to improve the efficiency of gas turbine.	8	16

➢ Explain the principles of jet propulsion 4.1 Classification and applications of gas turbine, Constant pressure gas turbines. Closed cycle and open cycle gas turbines and their comparison. 4.2 Methods to improve thermal efficiency of gas turbine Regeneration, inter- cooling, reheating ,representation on T-S diagram (no analytical treatment) , 4.3 Jet Propulsion, Principles of turbojet, turbo propeller, Ram jet.		
5. Refrigeration and Air- Conditioning Specific objectives: ➢ To describe the components and application of vapour compression system. ➢ Describe psychometric processes and air conditioning systems. 5.1 Refrigeration ---- 08 Marks Tonnes of Refrigeration, coefficient of performance. Vapour compression system, Vapour compression refrigeration cycle Subcooling and superheating, representation on p-h, T-S diagrams. Basic components of Vapour Compression Cycle, their function and location. Simple vapour absorption refrigeration system. Applications- Water cooler, Domestic refrigerator, Ice plant & cold storage. 5.2 Psychrometry ---- 08 Marks Properties of moist air-DBT, WBT, DPT, Specific humidity and relative humidity, Dalton's law of partial pressure psychrometric chart & psychrometric processes-sensible heating/cooling, humidification, dehumidification, evaporative cooling. 5.3 Air conditioning systems ---- 04 Marks Definition and classification of Air conditioning Systems. Construction and working of Window air conditioner and split air conditioner.	10	20
Total	**48**	**100**

Practical:
Skills to be developed:

Intellectual Skills:

1. Identify components of IC Engines.
2. Understand working principals of IC Engines, Compressors and refrigeration systems.
3. Analyze exhaust gases and interpret the results.
4. Select tools and gauges for inspection and maintenance.

Motor Skills:

1. Assemble and dismantle engine according to given procedure.
2. Operate IC Engine test rig, refrigeration test rig for measuring various parameters and plotting them.
3. Operate exhaust gas analyzer for measuring pollutants.

List of Practical:

1. Dismantling & assembly of petrol/diesel engine
2. Construction and Working of four stroke engine
3. Construction and Working of simple carburetor. Draw labeled diagram

4. Trial on single/multi cylinder petrol or diesel engine with heat balance sheet and calculate different performance parameters.
5. Conduct Morse Test on Multi cylinder Petrol engine and find BP, IP, FP.
6. Measure I.C.Engine pollutants with the help of Exhaust gas Analyzer.
7. Trial on two-stage Reciprocating compressor to calculate volumetric efficiency, overall efficiency, free air delivered.
8. Draw a labeled diagram of cooling and lubrication systems of I.C.Engine available in laboratory.
9. Trial on Refrigeration Test Rig for calculation of power consumed, refrigerating
10. Effect, C.O.P.
11. Trace the flow of refrigerant through various components in window air conditioner/
12. Split air conditioner. Draw the schematic diagram.

List of Assignments:

1. Study of manufacturer's catalogue for Reciprocating/Screw Compressor with respect to application, specifications and salient features.
2. Visit website- http://library.think.quest.org, http://www.grc.nasa.gov and prepare a brief report on gas turbine and jet propulsion.

Learning resources:

Books:

Sr. No.	Author	Title	Publisher
01	M. M. Rathore	Thermal Engineering	Tata McGraw Hill
02	V. Ganeshan	I. C. Engines	Tata McGraw Hill3rd edition
03	R. K. Rajput	Thermal Engg.	Laxmi Publication, Delhi
04	Patel, Karmchandani	Heat Engine Vol.I, II& III	Achrya Publication
05	P.K. Nag	Engg. Thermodynamics	Tata McGraw Hill 23rd edition
06	S. K. Kulshrestha	Thermal Engineering	Vikas Publishing House Pv.t Ltd.

Course Name : Mechanical Engineering Group

Course Code : ME/PG/PT/MH/MI

Semester : Fifth for ME/PG/PT and Sixth for MH/MI

Subject Title : Metrology and Quality Control

Subject Code : 17530

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	25#	--	25@	150

Rationale:

The Diploma mechanical Engineer should understand, select and use various measuring instruments as he often comes across measuring different parameters of machined components and the appropriate fitment of interchangeable components in the assemblies.

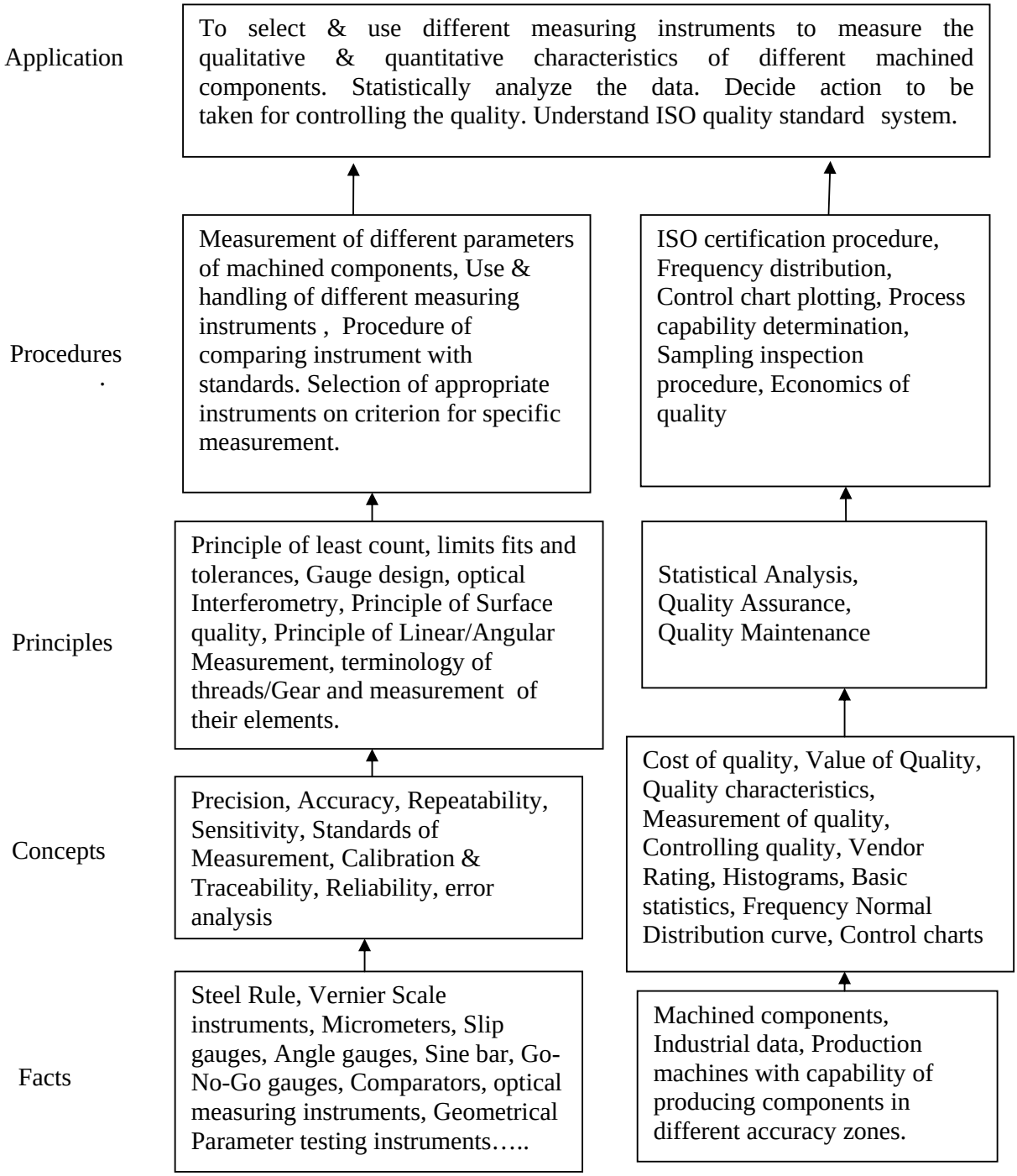
The knowledge of the subject also forms the basis for the design of mechanical measurement systems, design & drawing of mechanical components.

Objectives:

Students will be able to:

1. Understand and calculate the least count of all basic measuring instruments.
2. Select and use appropriate instrument/s for specific measurement.
3. Understand the systems of limits, fits and tolerances and correlate with machine drawing and manufacturing processes.
4. Analyze and interpret the data obtained from the different measurements processes and present it in the graphical form, statistical form for understanding the concepts of SQC.
5. Construct, draw and interpret the control charts.

Learning Structure:



Theory:

Topic & Content	Hours	Marks
1. Introduction to Metrology **Specific Objectives** • To understand the basics of Metrology & calculate the least count of measuring instruments. • To understand various standards, comparators, gauge selection and limit system. **1.1 Metrology Basics** 06 Marks Definition of metrology, objectives of metrology, Categories of metrology, Scientific metrology, Industrial metrology, Legal metrology, Need of inspection, **Revision of --**Precision, Accuracy, Sensitivity, Readability, Calibration, Traceability, Reproducibility, Sources of errors, Factors affecting accuracy, Selection of instrument, Precautions while using an instruments for getting higher precision and accuracy. Concept of least count of measuring instruments **(No questions to be set on revision).** **1.2 Standards and Comparators** 12 Marks Definition and introduction to line standard end standard, Wavelength standard and their comparison, Slip gauge and its accessories. Definition, Requirement of good comparator, Classification, use of comparators, Working principle of comparators, Dial indicator, Sigma comparator, Pneumatic comparator- high pressure differential type, Electrical (LVDT), Relative advantages and disadvantages.	09	18
2. Limits, Fits ,Tolerances and Gauges **Specific Objectives** • To understand the basics of limits, fits & tolerances • To calculate the basic and gauge tolerances. • To understand various types of gauges and their applicability. 2.1 Concept of Limits, Fits, And Tolerances, Selective Assembly, Interchangeability, Hole And Shaft Basis System, Taylor's Principle, Design of Plug, Ring Gauges, IS919-1993 (Limits, Fits & Tolerances, Gauges IS 3477-1973), Study of relation gauges, concept of multi gauging and inspection.	06	08
3. Angular Measurement **Specific Objectives** • To understand the basics of angular measurement and measure angles using different instruments. 3.1Concept, Instruments For Angular, Measurements, Working And Use of Universal Bevel Protractor, Sine Bar, Spirit Level, Principle of Working of Clinometers, Angle Gauges (With Numerical on Setting of Angle Gauges).Angle dekkor as an angular comparator.	04	08
4. Threads and Gear Metrology **Specific Objectives** • To Understand & use various methods of calculating thread elements and elements of gear tooth **4.1 Screw thread Measurements** 08 Marks ISO grade and fits of thread, Errors in threads, Pitch errors,	06	16

Measurement of different elements such as major diameter, minor diameter, effective diameter, pitch for internal and external threads , Three wire method, Thread gauge, screw thread micrometer, Working principle of floating carriage micrometer. **4.2 Gear Measurement & Testing** 08 Marks Analytical and functional inspection, Measurement of tooth thickness by constant chord method, base tangent method, gear tooth vernier, Errors in gears such as backlash, run out, composite, concentricity. Parkinson gear tester.		
5.Testing Techniques **Specific Objectives:** • To know terminology of surface finish & measure the surface finish of various components. **5.1 Measurement of Surface Finish** 06 Marks Primary and secondary texture, Sampling length, Lay, terminology as per IS 3073- 1967, direction of lay, Sources of lay and its significance, CLA, Ra, RMS values and their interpretation, Symbol for designating surface finish on drawing, Various techniques of qualitative analysis **5.2 Machine Tool Testing** 04 Marks Parallelism, Straightness, Squareness, Coaxiallity, roundness, run out, alignment testing of machine tools such as lathe, milling machine and drilling machine as per IS standard procedure. Study of optical flat for flatness testing.	06	10
6. Quality Control **Specific Objectives:** • To understand the concept of Quality, cost of quality. • To understand the concept and principles of TQM. **6.1 Quality :** 06 Marks Definitions, meaning of quality of produce& services, Quality characteristics, Quality of design, Quality of conformance, Quality of performance, Concept of reliability, Cost, Quality assurance, Cost of rework & repair, Quality & Inspection, Inspection stages. **6.2 Total Quality Management :** 06 Marks Principles and concept of total quantity management. a) Quality Audit: Concept of audit practices, lead assessor certification. b) Six sigma: Statistical meaning, methodology of system Improvement. c) Introduction of ISO 9001-2008.ISO-14000 and TS 16949.	07	12
7. Statistical Quality Control **Specific Objectives:** • To know the basics of statistics. • To understand different data types and analyze & interpret the data **7.1 Statistical Quality Control** 20 Marks Basics of Statistical concepts, Meaning and importance of SQC, Variable and attribute Measurement. control charts – inherent and assignable sources of variation, control charts for variables – X & R charts, control charts for attributes p, np, C charts, process capability	10	28

of machine, , C_p and C_{pk} calculations, determination of statistical limits, different possibilities, Rejection area, Statistically capable and incapable processes **7.2 Acceptance Sampling** 08 Marks Concept, Comparison with 100% inspection, Different types of sampling plans, sampling methods, merits and demerits of acceptance sampling. OC Curve.		
Total	**48**	**100**

Practicals:
Skills to be developed:

Intellectual Skills:

1. To select basic measuring instruments.
2. To calculate least count of various measuring instruments.
3. To collect, record and analyze the data.
4. To interpret the results of data analysis.

Motor Skills:

1. Measure the dimensions of component using various instruments.
2. To take care of instruments.
3. To draw various charts and curves related to data.
4. To handle various instruments.

List of Practical:

1. Measurement of various dimensions& dimensional parameters using instruments such as radius gauge, pitch screw gauge, filler gauge, vernier caliper, vernier height gauge, vernier depth gauge, dial type vernier caliper, micrometer, inside micrometer, tube micrometer.

Note:- * The student should measure at least 3 dimensions of given job and take 5 readings per dimension.

* Individual performing the measurement with one setup on one surface plate and simultaneous 4 to 5 setup should be kept ready for measurement.(At least 10 Vernier calipers, Micrometers with different range i.e. 0-25mm two nos. , 25- 50 two nos. Inside micrometer, tube micrometer, V anvil micrometer at least one.)

1. To set the Adjustable snap gauge GO end and NOGO end for a given dimensions using slip gauges.
2. Inspection of given components using Dial Indicator as a mechanical comparator.
3. To check the given component using high pressure Dial type pneumatic comparator.
4. To find unknown angle of component using bevel protractor and verify the same using sine bar/ sine center and slip gauges.
5. To measure the angle of component with the Angle Dekkor / Autocollimator using angle gauge.
6. Measurement of screw thread elements by using screw thread micrometer, screw pitch gauge & their verification with the help of profile projector/tool maker's microscope.
7. Measurement of gear tooth elements by using gear tooth vernier caliper and verification of gear tooth profile using profile projector.
8. To measure surface roughness using surface roughness measuring instrument. Measure surface roughness of turning, milling, shaping, grinding and lapping surfaces.
9. Testing of lathe machine/drill machine for parallelism, squareness, trueness by Test Dial indicator.
10. Draw the frequency histogram, frequency polygon for given samples (min 50 readings) and find mean, mode, median.

11. To draw the normal distribution curve and find standard deviation, variance, range and determine process capability.
12. To draw and interpret the control Charts (X – bar and R – chart, P chart, C chart) for given data.
    a. **Batch size of students for experiment 2 to 13 shall be 4 to 5.**
    b. **4 to 5 experimental setups should be arranged simultaneously.**

Assignment:

1. Visit the industries to collect the data for p and c chart, study the coordinate measuring machine and study the quality management systems**.**
2. Selection of comparators for the given dimensional data

Learning Resources:

Sr. No.	Author	Title of Book	Edition	Publisher
01	R. K. Jain	Engineering Metrology	2010	Khanna Publisher, Delhi.
02	M. Mahajan	Text Book of Metrology	Second Reprint-2010	Dhanpat Rai & Co.
03	I.C. Gupta	A text book of Engineering Metrology	--	Dhanpat Rai and Sons
04	M. Mahajan	Statistical Quality Control	2010	Dhanpat Rai and Sons
05	Douglas C. Montgomery	Statistical Quality Control	Sixth reprint 2011	Wiley India Pvt. Ltd.
06	Dale H. Besterfield and others	Total Quality Management	Third Reprint 2012	Pearson

2. IS/ International Codes:

IS 919 – 1993 Recommendation for limits, fits and tolerances
IS 2029 – 1962 Dial gauges.
IS 2103 – 1972 Engineering Square
IS 2909 – 1964 Guide for selection of fits.
IS 2921 – 1964 Vernier height gauges
IS 2949 – 1964 V Block.
IS 2984 – 1966 Slip gauges.
IS 3139 – 1966 Dimensions for screw threads.
IS 3179 – 1965 Feeler gauges.
IS 3455 – 1966 Tolerances for plain limit gauges.
IS 3477 – 1973 Snap gauges.
IS 6137 – 1971 Plain plug gauges.
IS 3651 – 1976 Vernier Caliper
IS 4218 - Isometric screw threads
IS 4440 – 1967 Slip gauges accessories
IS 5359 – 1969 Sine bars
IS 5402 – 1970 Principle and applications of sine bars

Course Name : All Branches of Diploma in Engineering & Technology

Course Code : EJ/EN/ET/EX/EV/IC/IE/IS/MU/DE/ME/PG/PT/AE/CE/CS/CR/ CO/CM/IF/ EE/EP/CH/PS/CD/ED/EI/CV/FE/FG/IU/MH/MI/TX/TC/DC/AU

Semester : Fifth for EJ/EN/ET/EX/EV/IC/IE/IS/MU/DE/ME/PG/PT/AE/CE/CS/CR/ CO/CM/IF/EE/EP/CH/PS/AU and Sixth for CD/MH/IU/CV/FE/FG/MI/ ED/EI/DC/TC/TX

Subject Title : Behavioural Science

Subject Code : 17075

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
01	--	02	--	--	--	25 #	25 @	50

Rationale:

With increased globalization and rapid changing business expectations, employers are looking for wide cluster of skills to cater to the changing demand. Personality traits and soft skills are playing a key role in a student's career in this changing scenario. Corporate houses look for soft skills that supplement hard skills.

Addition of behavioural science in curriculum is intended to enhance the efficiency of a person so that he can contribute to overall growth of organisation. It aims at developing insight into leadership, team building, motivation, interpersonal relationship, problem solving, decision making and aspects of personality in a technician's profile. Addition of the topic of organizational culture will further mould him/ her in the organisational role.

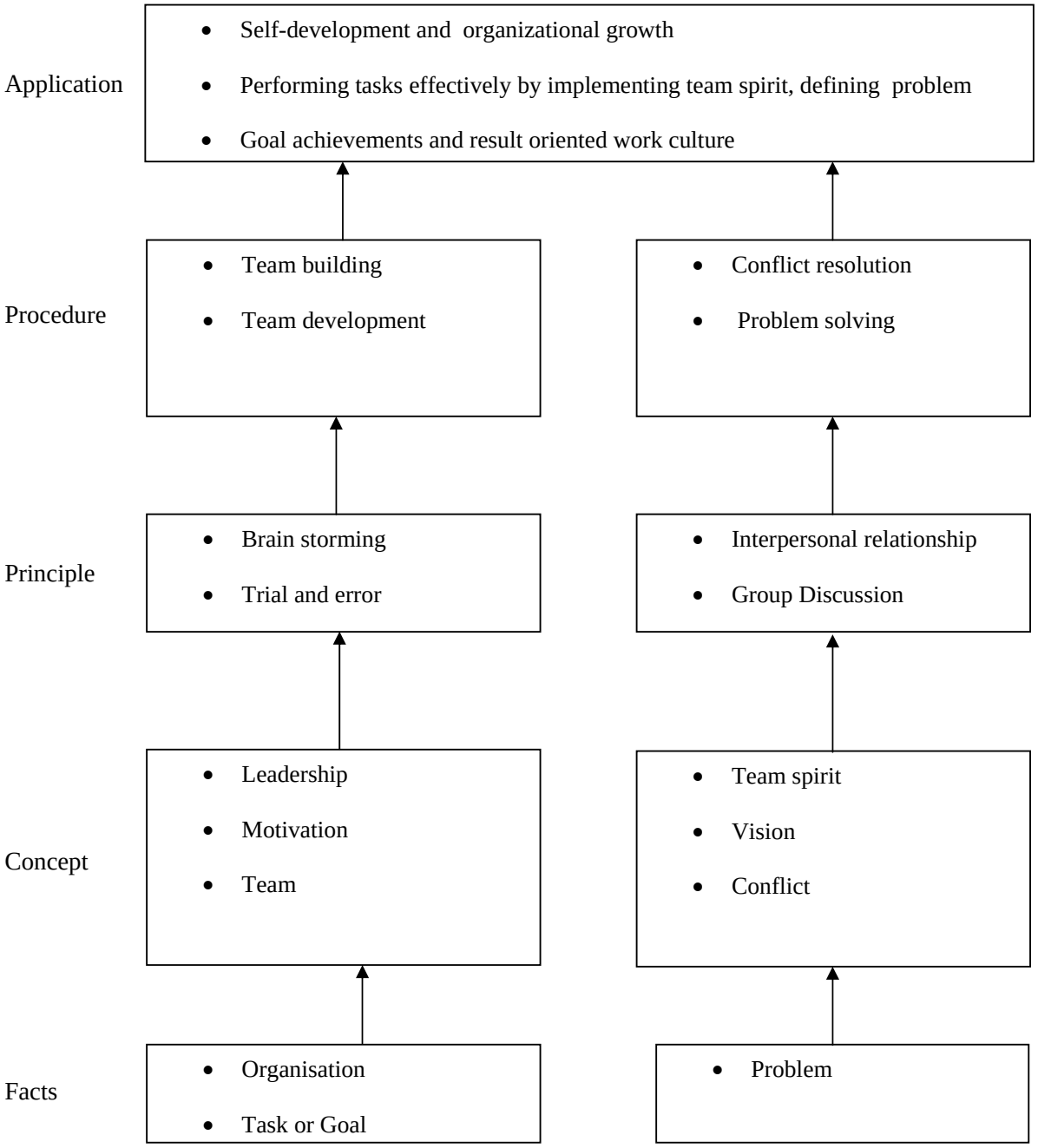
This subject of 'Behavioural Science' provides a broad base in which a technician can develop a successful career in the world of work.

General Objectives:

After studying this subject, the students will be able to:

1. Develop him/her as Team leader.
2. Use self-motivation and motivate others.
3. Build a team and develop team spirit among the team members.
4. Improve the interpersonal relationship skills.
5. Learn Problem solving and decision making skills.
6. Discuss a particular topic in a group and face the interview.

Learning Structure:



Theory:

Topic and Contents	Hours
TOPIC 1: LEADERSHIP Contents: 1.1 Introduction – Importance, examples of different types of leaders. 1.2 Meaning and Definition of Leadership. 1.3 Leadership qualities – Confidence, Vision, Communication Skills, influencing people etc. 1.4 Types of Leadership styles, their advantages and disadvantages – Autocratic, Democratic, Delegative, Bureaucratic and Laizze Fairie.	02
TOPIC 2: MOTIVATION Contents: 2.1 Meaning and Definition of motivation. 2.2 Types of motivation. 2.3 Maslow's Motivation theory. 2.4 Job characteristic model to enhance motivation.	03
TOPIC 3: TEAM BUILDING Contents: 3.1 Definition of Team. 3.2 Difference between Group and Team. 3.3 Need for formation of good team (vision, trust, cooperation, initiative, etc.) 3.4 Approach to Team building (Personality based, activity based, skill based, problem solving based, etc.)	02
TOPIC 4: CONFLICT RESOLUTION Contents: 4.1 Definition of Conflict. 4.2 Types of Conflict – Functional and Dysfunctional 4.3 Sources of Conflict – Ego, Authority, Frustration etc. 4.4 Positive and Negative effects of conflicts. 4.5 Methods of Conflict resolution – Compromising, withdrawal, forcing.	04
TOPIC 5: PROBLEM SOLVING AND DECISION MAKING Contents: 5.1 Steps in Problem Solving. 5.2 Methods used for solving problems – trial and error method, brain storming, lateral thinking method. 5.3 Techniques used for Decision making- Decision tree, Decision Matrix, Mind Mapping etc.	03
TOPIC 6: GROUP DISCUSSION AND INTERVIEW TECHNIQUES Contents: 6.1 GROUP DISCUSSION • Objectives of Group Discussion (ability to work in team, speaking and listening skills, leadership, creativity) • Does and Don'ts of Group Discussion. • How to conclude Group Discussion.	02

6.2 INTERVIEW TECHNIQUES • Types of Interviews. (patterned, stress, behavioural) • Dress Code, Body Language and Communication Skill. • Probable questions for Interview. • Telephonic or Video Interview.	
Total	**16**

Practical:
Skills to be developed:

Intellectual Skills:

1. Develop ability to find his strengths.
2. Select proper source of information.
3. Follow the technique of time and stress management.
4. Set the goal.

Motor Skills:

1. Follow the presentation of body language.
2. Work on internet and search for information.
3. Prepare slides / transparencies for presentation.

List of Practicals / activities:

1. Form a group of 4 or 5 students and discuss the topic 'Qualities of an effective leader'. Each group will prepare its list with justification to the entire class and write an assignment under the guidance of subject teacher.
2. Form a pair of student and each one from pair will ask each other questionnaire on motivation, self-motivation, experiences that motivated him or other which him for success in the past and write an assignment under the guidance of subject teacher based on discussion.
3. Form a group of 4 or 5 students and assign them a group activity such as 'making a shape from match stick (50 to 100 match sticks) without guidance and without group discussion.
4. The group as in activity 3 will now perform the same activity. After group discussion and under guidance of subject teacher, each student from a group will write an assignment for both the activities and write their inferences with reference to group discussion, team development, team building, etc.
5. Form a group of 8 to 10 student and arrange a group activity such as;
   - Industrial visit.
   - Visit to any historical place/fort/museum, etc
   - Housekeeping and cleaning of any laboratory/seminar hall for any function.

   After the execution of activity student will write an assignment under guidance of teacher keeping in mind individual role, purpose of activity, inter dependency of work or task, coordination of person and task involved and final performance.
6. Write an assignment on interpersonal relationship and conflict management with student's personal experience of solving conflicts.
7. Form a group of 20 students and ask them to prepare a list of 8 to 10 problems affecting the institute. Subject teacher should analyze one such problem on black board using 'Fish bone technique' with the participation of students. Students will write an assignment consisting;
   - Apparent problem statement.
   - Analysis of the causes.

- Definition of real problem.

8. The subject teacher starts the session with 'Statement of the problem' written on the black board. After ensuring that all the participants are at the same level of understanding the statement of problem, he initiates NGT (Normal Group Technique) to arrive at maximum possible number of creative solutions.
   Based on ranking matrix the group will arrive at feasible solutions and students will write an assignment consisting of;
   - Problem Statement.
   - Model of problem solving.
   - List of creative solution suggested by participants.
   - Write the most feasible solution based on given criteria.

9. Form a group of 4 to 5 students and give them a topic for GD for 10 to 15 minutes. Teacher should analyse GD on certain parameters and students will write an assignment on aspects of GD and prepare a format (suggested or designed by teacher) which gives details of GD carried out.
10. Arrange a guest lecture of H.R. Person from industry/expert in interview technique and conduct mock interview of each student. Student should write a report on this activity.
11. Arrange a visit to industry and gather information about organisation, product, turnover, work culture, vision/mission statement, quality policy, Corporate social responsibility etc and write a report on it.

Note - Subject teacher shall guide the students in completing the assignments based on above practicals.

Learning Resources:
Books:

Sr. No.	Author	Name of Book	Publication
1	Subject Experts-MSBTE	Handbook and assignment book on Development of Life Skills-II	MSBTE
2	Dr. Kumkum Mukherjee	Principles of management and organizational behaviour	Tata McGraw Hill Education Pvt Ltd.
3	Dr.T.Kalyana Chakravarti Dr.T.Latha Chakravarti	Soft Skills for Managers	Biztantra
4	Barun K Mitra	Personality Development and soft skills	Oxford University Press
5	Priyadarshini Patnaik	Group discussion and interview skills	Foundation Books

Course Name : Mechanical Engineering Group

Course Code : ME/PG/PT/MH/MI/FG/FE

Semester : Fifth for ME/PG/PT/FG and Sixth for MH/MI/FE

Subject Title : CNC Machines

Subject Code : 17064

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
01	--	02	--	--	50#	--	25@	75

Rationale:

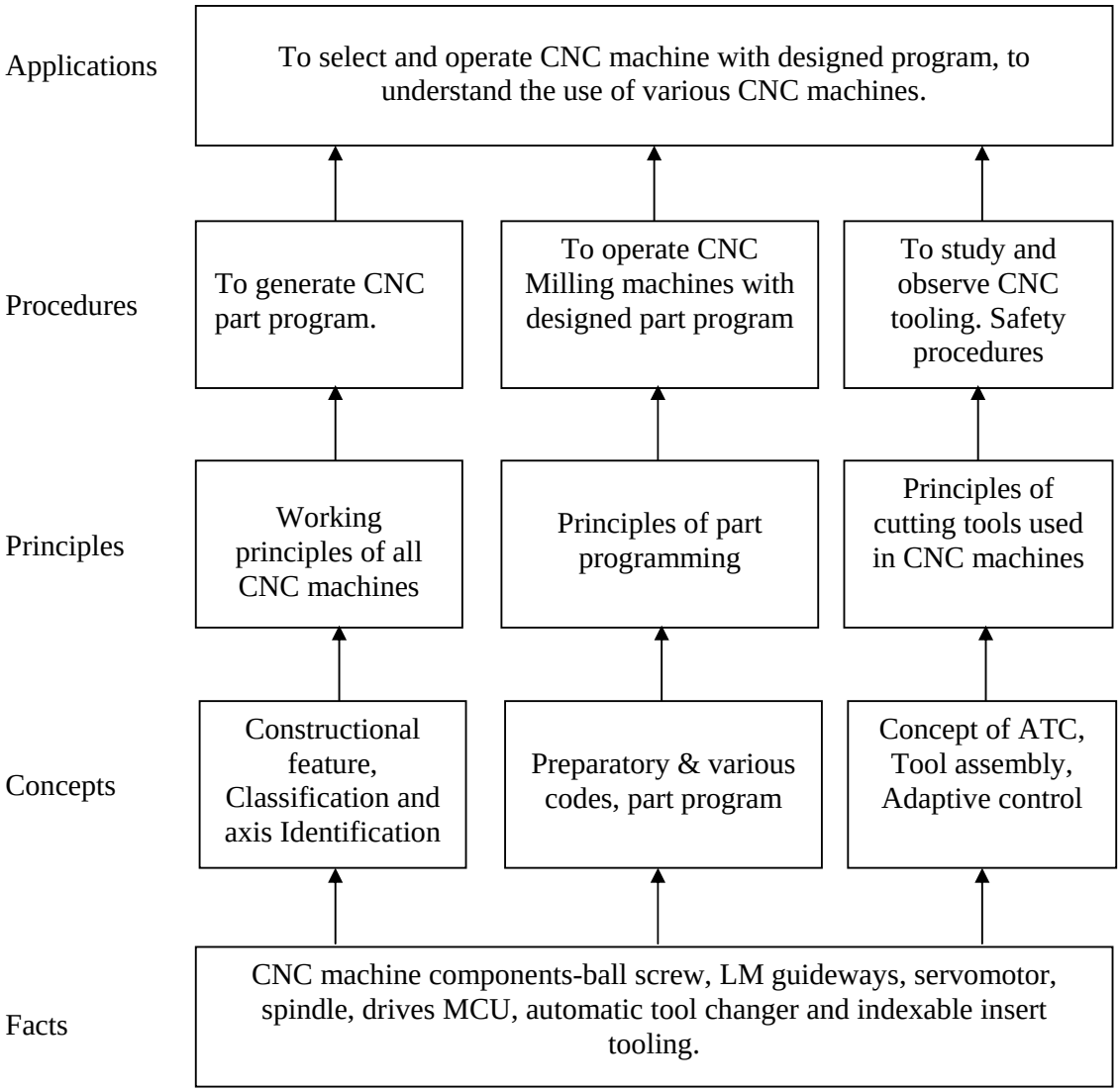
This is Technology subject which has relevance with the subjects taught earlier namely Manufacturing Processes and advanced manufacturing processes. After getting conversant with the basic manufacturing processes and production processes, it is necessary for a technician to know about the advancements in the area of manufacturing and production processes. The subject will impart knowledge & skills necessary for working in modern manufacturing demands and environment. This subject will help the student to get familiarized with working principles and operations performed on CNC machining centers, generation of part program and study tooling of CNC machine.

Objectives:

The student will be able to

1) Know different types of CNC machines,
2) Understand the different codes used in CNC programming.
3) Know the Operation and control of different CNC machine and equipments.
4) Adopt different tooling while working on various CNC machines.

Learning structure:



Theory:

Topic and Content	Hours
1. Introduction to CNC machines **Specific objectives:** ➢ State different types and advancements in CNC machines ➢ Describe Construction and working of CNC turn-mill center **Content:** 1.1 Classification of CNC machines 1.2 Axis standards and its identification. 1.3 Construction and working of CNC turning centre, VMC and HMC 1.4 Construction and working of CNC turn mill centre 1.5 Construction and working of Multi- axis CNC machines 1.6 Construction and working of Pallet type CNC machine 1.7 Construction and working of CNC based Coordinate Measuring Machine.	4
2. Constructional features and working of CNC machines **Specific objectives:** ➢ Describe construction and working of the different components, subassemblies, assemblies and peripherals of CNC machines **Content:** 2.1 Bed and machine frame construction. 2.2 Spindle constructional details 2.3 Constructional details and working of ball screw and L.M. guideways. 2.4 Various Spindle drives used in CNC machines. 2.5 Working of Machine control unit. 2.6 Types of lubrication systems used for CNC machines. 2.7 Working of swarf removal arrangement. 2.8 Working of hydraulic and pneumatic systems used for chuck, tool and pallet changing in CNC machines.	4
3. CNC Part programming **Specific objectives:** ➢ Describe CNC part programming according to the drawing of the component **Content:** 3.1 NC words, G codes, M codes. 3.2 Programming format, word statement, block format. 3.3 Tool offsets and tool wear compensation. 3.4 Part programming containing Subroutines, Do- loops and Canned cycles. 3.5 Introduction to Macro programming.	4
4. Tooling for CNC machines **Specific objectives:** ➢ State types of CNC cutting tools ➢ Describe tool presetting procedure **Content:** 4.1 Introduction 4.2 Types of CNC Cutting tools 4.3 Types of indexable inserts with its geometry 4.4 Construction of tool holding assembly 4.5 Tool presetting procedure 4.6 Working of Automatic Tool Changing (ATC) device and types of tool magazine 4.7 Safety Procedures, alarms, fool-proof procedures. 4.8 Online measurement of dimensions, cutting forces, Adaptive controls, communication with servers.	4

4.9 Fixtures used in CNC machines.	
Total	**16**

Practicals:
Skills to be developed.

Intellectual Skills:
1) To select the appropriate CNC machine for the given component.
2) To select the appropriate tools for the given component.
3) To generate programme for the given component.
4) To calculate the cycle time for the given component.

Motor Skills:
1) To feed the programme to CNC machine.
2) To conduct the programme in single block mode and dry run.
3) To carry out job production on CNC machine.
4) To carry out changes in job and carry out compensation.

Notes:
1) The College/Institute should purchase at least one CNC production machine.
2) The requisite time of practical mentioned in the scheme should be allotted to the students. A group of 4-5 students can handle machine for 30mins in 2 hrs. practical. Whenever students are free they can approach the lab in charge to work on machines.
3) Students can model components required for their project (6^{th} sem) on 3D modeling software, thereafter if students manufacture these components on CNC machines, it is highly appreciable.
4) The Workshop Superintendent/ HOD should personally see that the CNC Practicals are conducted in his Institute.

Guidelines for Practical Examination

An examiner must prepare 6 assignments on turning and 6 assignments on milling. See that the task can be completed in 1 hr. A group of 4 students can pick up **one** assignment randomly. The group should write part programme, enter into machine, dry run and manufacture the component. Evaluation of students based on their contribution in activities shall be done by the internal as well as external examiner.

List of practical
1. One practical on single block mode & dry run on CNC turning center for production job part programme (Batch of 4-5 students) and verification using any simulation software.
2. One practical on single block mode & dry run on CNC milling for production job part programme (Batch of 4-5 students) and verification using any simulation software.
3. One job on CNC lathe having plain turning, taper turning, step turning, threading, boring and grooving (Batch of 4-5 students).
4. One job on CNC milling having following operations – face milling, slotting, contour machining (Batch of 4-5 students)
5. One assignment on indexable inserts used in CNC tooling with its geometrical details and ISO codes, nomenclature.
6. Conduct a practical on presetting of a milling cutter or one assignment on tool presetting procedure.
7. Visit to CNC machine (Production) shop having turning and machining centre to observe construction and working of CNC turning and vertical machining centre, write visit report and draw plant layout.

8. One assignment on CNC programming containing subroutines, do-loop and canned cycle
9. Visit to industry having CNC-CMM machine and inspect various dimensions and geometry of production component.

List of Books

Sr. No.	Author	Title	Publisher
1	HMT, Bangalore	CNC Machines	New age International Limited
2	P. N. Rao	CAD/CAM Principles Applications	Tata McGraw Hill
3	Pabla B. S. & M. Adithan	CNC Machines	New age International Limited
4	Groover , Zimmers	CAD/CAM Computer Aided Design & Manufacturing	Pearson
5	HMT, Bangalore	Mechatronics	Tata McGraw Hill
6	Chougule N. K.	CAD/CAM/CAE	Scitech Publication Pvt. Ltd.
7	Binit Kumar Jha	CNC Programming Made Easy	Vikas Publishing House Pvt. Ltd. New Delhi. Revised Edition 2010.

Note: Practice of Programming is required for students using Simulation Software

Course Name : Mechanical Engineering Group

Course Code : AE/ME/PG/PT/MH/MI

Semester : Fifth for AE/ME/PG/PT/FG and Sixth for MH/MI/FE

Subject Title : Professional Practices-III

Subject Code : 17065

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
--	--	03	--	--	--	--	50@	50

Rational:

Overall professional development of diploma mechanical engineers is the need of the day for enabling them to sustain in competitive global environment.

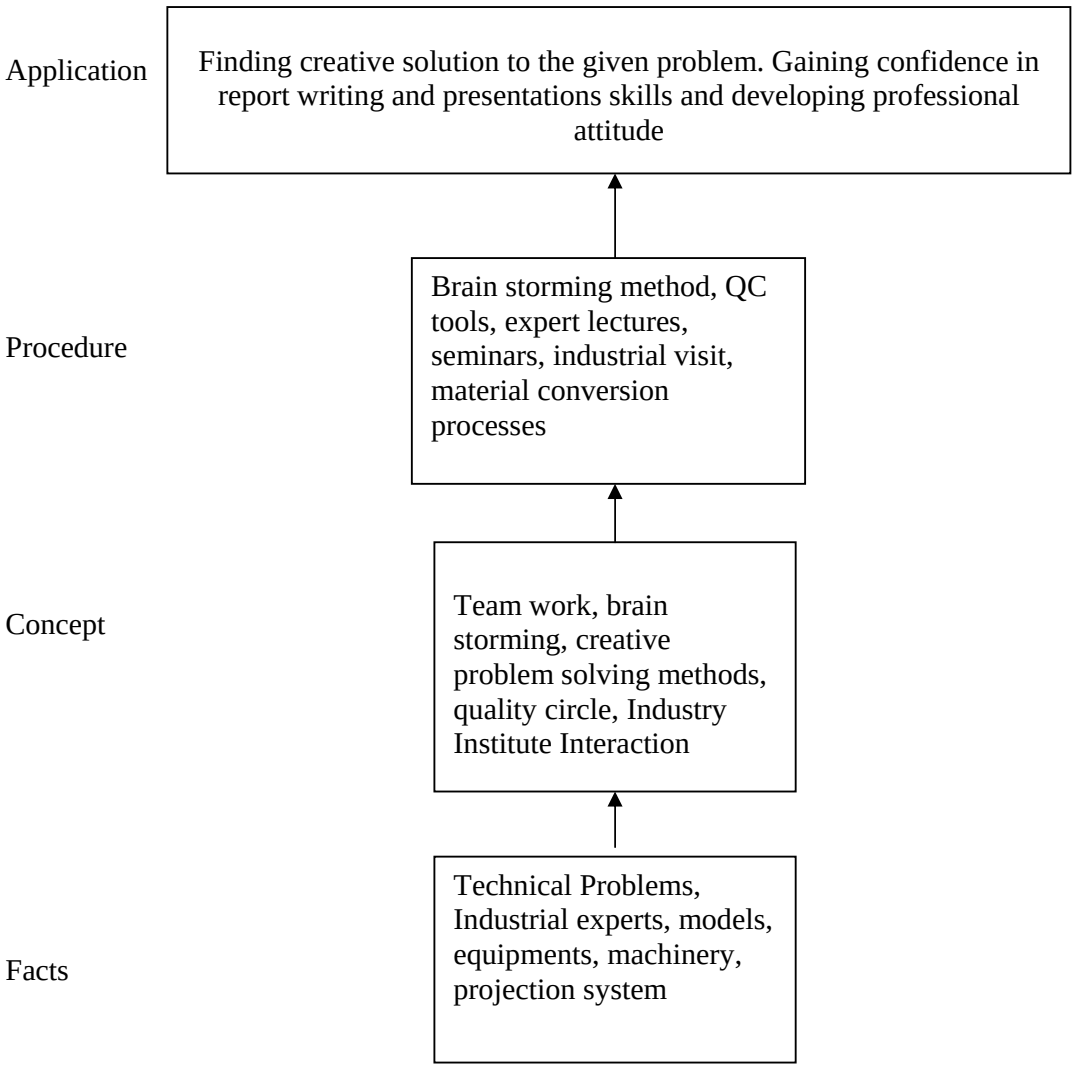
Professional development of Diploma engineering students is to be done by exposing them to various simulative situations in the industries. This can be achieved by inculcating attitude to face the problems, get alternative solutions and validation of the selected alternatives. This is achieved by involving students in activities such as inviting experts from various industries for sharing their experiences, arranging industrial visits, quality circles, seminars and mini projects activities etc.

General Objectives:

Student will be able to:

1. Identify, select and solve the problems.
2. Acquire information from different sources.
3. Prepare technical report and present seminar using power projection system.
4. Interact with peers to share thoughts.
5. Make them work with their own hands.
6. Work in a team and develop team spirit.

Learning Structure



Contents:

Activity	Practical Hours
1. Idea Generation for final semester Project selection: The student should use innovation principles for Idea generation .These ideas should lead to selection of Project. Head of Department should allot the project guides for the activity and form groups of four students per project. Following are some of the guidelines for projects selection. • Development of working models. • Development of attachments to machine tools. • Reconditioning of existing equipments, machines in the Institute. • Industrial Problem Solving. • Interdisciplinary Projects. • Use of Non conventional Energy sources. • Use of appropriate technology. • Agro based projects to reduce drudgery of farmers. • Ergonomic equipments • Jig, fixtures, dies, special purpose tools • Any project on Low Cost Automation • Automation Problems in industries • Experimental setups required in laboratories for measurement of parameters and component performance. • Any other project suitable for Industry and Institute. **Note:-** The project group should submit their progress report, activity planning, any preliminary calculations to evaluate the project to be submitted at the end of the semester. The student should submit a report for the project which will have proportional weightage in the term work	06

2. Industrial Visits Structured industrial visits be arranged and report of the same shall be submitted by the individual student, to form a part of the term work. Following are the suggested types of Industries/ Fields. The subject teacher(s) have liberty to select nearby organization/industry • Automobile manufacturing / press component / auto component manufacturing units to observe the working of SPM / Non Conventional Manf process / CNC / FMS / Robots • Refrigeration and air conditioning manufacturing / servicing units / industries / workshops • Automobile service stations for four wheelers/Wheel Balancing unit for light and/or heavy motor vehicles/exhaust gas analysis and vehicle testing / PWD / ST workshop. • Co-ordinate measuring machine to observe its construction working specifications and applications. • Engine Testing unit to gather details regarding the testing procedures/parameters etc. • Food processing/ Dal mill/ Oil Mill/ Automated bakery unit. • Textile industry / Textile machinery manufacturing / garment manufacturing / embroidery / textile printing and dying units. • Hydro electric and Thermal power plants. • Automotive Research Association of India, Pune, Central Institute of Road Transport, Pune, Vehicle Research and Development establishment, Ahmednagar. • Safety museum at Central Labour Institute, Sion, Mumbai • Common Facility Center by MSME, GOI. • Auto Cluster projects of MSME, GOI. • CIPET and IGTR Aurangabad • Tyre retreading, paint manufacturing, foundries, forging unit, heavy fabrication unit, steel and wooden furniture manufacturing • Agricultural equipments manufacturing units. • Hardware and Machinery stores selling agro equipments • Plastic injection molding, extrusion, blow molding. • Stone crushers / hot mix plant/ service stations of JCBs and other earthmoving equipments • Note:- One Industrial visits be arranged per practical batch of students.	06

3. The Professionals/ Industrial Expert Lecture/s Experts / Professionals from different field/industries are invited to deliver lectures of 2 Hrs. duration at least TWO occasions. The topics may be selected by the teacher / industry expert to develop required skills .The following topics may serve guidelines. • Vehicle testing. Vehicle aerodynamics & design. • Modern automobiles systems, Hybrid motor vehicles, electric vehicles, MPFI, ABS etc. • Environmental pollution & control, Automobile pollution, norms, act. • Earth moving machines. • Biotechnology • Nanotechnology • CAD, CAM, Computer Integrated Manufacturing, Material resources planning, Enterprise resources planning • Product design and modeling, Rapid prototyping • Programmable logic controllers, Automation, Robotics, Automated Guided Vehicles, Non industrial robots, • TQM, 5S, JIT, KAIZEN, Lean Manufacturing., World class Manufacturing, Pokayoke, Total Productive Maintenance, Six Sigma. • Packaging technology • Appropriate technology • LPG / CNG conversion kit. • Current HR Policies, Labor Act. • ISO implementation, • Import – Export policies and procedures, Taxation. • IPO, Mutual Fund, FPO, Share- Commodity trading and Investment. • Role of Insurance, Value Assessors in industry and society, Vehicle valuers, • Trends in modern agriculture engineering • Sustainable development, Green Environment, Solar and alternative fuels, Rain water harvesting, Disaster management. • Innovation Principles. • Opportunities in software industries. • Supply chain management. E-commerce. • Energy Audit. • Road Safety, Road Signs, Prevention of accidents on Roads, First aid. **Note:** The brief report to be submitted on these lectures by each student as a part of Term work	06

4. Students Quality Circles: The students should form Quality Circles consisting of group of six to eight students and brain storm on various problems faced by students, use QC tools to find root causes and alternative solutions. Following are some of the problems undertaken by students Quality Circle - Poor vocabulary of Diploma Engineering students Poor practical skills of Diploma Engineering students Poor Journal preparation of Diploma Engineering students Poor Entrepreneurial abilities of Diploma Engineering students Students and teacher can select different problems according to their priorities. The students should prepare QC register and Case Study presentation. Present this case study in the class. Such Quality Circles can participate in State level and National Level Conventions organized by Quality Circle Forum of India. For additional information visit website www.qcfihq.com	12
5. Seminar : Seminar topic may be related to the subjects of fifth semester / topics from guest lectures. Students shall submit a report of at least 5 typed pages (font size 12 all Margins 1" A4 size) (Presentation time – 10 minutes per student)	06
6. Mini Projects : (in a group of 4-5 students) Students can choose any mini project of their interest. Mini Projects means a short term project which may be completed in 2 to 3 months and with a limited scope. Suggestive topics for guidance are as follows : CNC Programming and manufacturing, Advanced mechanism, Model making--conveyors, agro equipments, wax/ thermocol prototypes, factory layouts, string diagrams,. Standard Operating Procedures for various machines Students and teachers are free to select any techno-viable mini project. Students shall arrange exhibition of all mini projects in the class/hall and present the task to the audience/ experts/examiners. The student shall submit a brief report (Max. 5 pages) of the mini project.	12
Total	**48**

Note for Industrial In-plant Training

PART A - Term Work / Assignments mentioned in the curriculum of Professional Practices-III

PART B - In plant Training (Minimum Two Weeks)

The students who are willing to undergo In Plant Training should complete minimum two weeks training in summer vacation at the end of IVth Semester examination in following types of organizations

1. Small scale industry
2. Private Ltd organization / industry
3. Public Ltd organization
4. Machine shop / Work shop
5. Tool room

6. Press shop
7. Die manufacturing unit
8. CNC shop/Center
9. Fabrication shop
10. Foundry
11. Heat treatment shop
12. Surface plating shop
13. Rubber components manufacturing unit
14. Plastic manufacturing unit
15. Tyre retreading shop
16. Four wheeler/two wheeler service station
17. Earth moving machinery
18. Rice mill / Sugar mill / Food industry
19. Farm equipment manufacturing unit
20. CAD / CAM design unit
21. Any other relevant industry/shop in the field of Mechanical / Automobile / Production Engineering

Student should complete his report (Duly typed and bound) and submit along with Term Work in **PART - A**

Note – Student should attach the certificate along with training report duly certified by the competent authority (Ex. Engineer/Manager/Director/Owner etc.) from the concerned industry for the validity of in plant training

Guidelines for contents in the report

- Name and type of industry
- Plant layout (Actual)
- No of departments / employees
- Nature of product / manufacturing process/service etc.
- Types of machines / equipments used and their maintenance.
- Machine specifications/make/capacity/efficiency etc.
- Measuring instruments used, their types and applications.
- Name of components/items/subcomponents/assemblies/subassemblies produced.
- Raw materials used / inventory control.
- Quality systems employed - TQM/Kaizen / 5S / Quality circle.
- Information about customer and competitor
- Conclusion - knowledge gained by the student, skills developed / learned / enhanced.
- Opinion / view of student about in plant training.
- Any other relevant information.

Guidelines for assessment of Term Work and in plant training report
The assessment of Term Work and in plant training report shall be done on following basis

Assignments completed as per PART A (converted from D4 format)	In plant training	Total Term Work Marks
40	10	50

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher
01	NRDC, Publication Bi Monthly Journal	Invention Intelligence Journal	National Research Development Corporation, GOI.
02	DK Publishing	How things works encyclopedia	DK Publishing
03	QCFI Publication, Secunderabad	Quality Circle Concepts and Implementation, 5S, KAIZEN 6 SIGMA TRIZ TQM SPC TPM SMED ERP	QCFI Publication, Secunderabad Visit website www.qcfihq.com for details
04	Paul Trott	Innovation Management and New Product Development 4th Ed.(2008)	Pearson Education
05	Joe Tidd	Managing Innovation,3rd Ed.	Wiley India

2. CD-ROM:

Federation of Indian Chambers of Commerce and Industries (FICCI) has developed 7 internationally acclaimed CD-ROM titles on various aspects of Quality Management & Business Excellence, which enable the organizations in achieving their 'mission critical objectives' in a cost-effective manner.

- Developing continuous improvement as an organizational strategy.
- Strategies for becoming a customer driven organization.
- Six Sigma - A breakthrough strategy.
- Seven steps to World Class Manufacturing.
- Maximizing business results and competitive advantages.
- Concise Encyclopedia of Business Excellence.
- Developing a passion to excel.

For more details log on to: www.ficci.com/fqf03/index.htm

3. Web Sites:

www.start2think.com
www.Innovationgoldmine.com
www.engineeringforchange.org
www.qcfihq.com
www.wikipedia.com
www.slideshare.com
www.teachertube.com

Industrial Training (Optional)

- Students who have completed industrial training in summer vacation after 4th Semester will be granted exemption for activities related to topic 1 to 4.

- These students shall submit report of Industrial training signed and certified by authorities from Industry. Student will give seminar on industry training attended by him.

- Evaluation will be done on seminar and report submitted by student.

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

TEACHING AND EXAMINATION SCHEME FOR POST S.S.C. DIPLOMA COURSES

COURSE NAME : DIPLOMA IN MECHANICAL ENGINEERING

COURSE CODE : ME

DURATION OF COURSE : 6 SEMESTERS for ME and 8 SEMESTERS for MH/MI **WITH EFFECT FROM 2012-13**

SEMESTER : SIXTH **DURATION : 16 WEEKS**

PATTERN : FULL TIME - SEMESTER **SCHEME : G**

SR. NO	SUBJECT TITLE	Abbreviation	SUB CODE	TEACHING SCHEME			EXAMINATION SCHEME									SW (17600)
							PAPER HRS.	TH (1)		PR (4)		OR (8)		TW (9)		
				TH	TU	PR		Max	Min	Max	Min	Max	Min	Max	Min	
1	Management $	MAN	17601	03	--	--	1&½	50#*	20	--	--	--	--	--	--	50
2	Industrial Fluid Power	IFP	17608	04	--	02	03	100	40	--	--	25#	10	25@	10	
3	Production Engineering & Robotics β	PER	17609	04	--	--	03	100	40	--	--	--	--	--	--	
4	Design of Machine Elements	DME	17610	04	--	02	04	100	40	--	--	25#	1 0	25@	10	
5	**Elective (Any One)**															
	Renewable Energy Sources & Management	RES	17611	03	--	02	03	100	40	--	--	--	--	25@	10	
	Refrigeration & Air Conditioning	RAC	17612	03	--	02	03	100	40	--	--	--	--	25@	10	
6	Solid Modelling	SMO	17063	01	--	02	--	--	--	25#	10	--	--	25@	10	
7	Project β	PRO	17090	--	--	04	--	--	--	--	--	50#	20	50@	20	
8	Entrepreneurship Development β	EDE	17099	01	01	--	--	--	--	--	--	--	--	25@	10	
			TOTAL	**20**	**01**	**12**	**--**	**450**	**--**	**25**	**--**	**100**	**--**	**175**	**--**	**50**

Student Contact Hours Per Week: **33 Hrs.**

THEORY AND PRACTICAL PERIODS OF 60 MINUTES EACH.

Total Marks **: 800**

@ - Internal Assessment, # - External Assessment, [ ] No Theory Examination, $ - Common to all branches, #* - Online Examination, β - Common to AE, PG, PT, FG, FE

Abbreviations: TH-Theory, TU- Tutorial, PR-Practical, OR-Oral, TW- Term Work, SW- Sessional Work

- Conduct two class tests each of 25 marks for each theory subject. Sum of the total test marks of all subjects is to be converted out of 50 marks as sessional work (SW).
- Progressive evaluation is to be done by subject teacher as per the prevailing curriculum implementation and assessment norms.
- Code number for TH, PR, OR, TW are to be given as suffix 1, 4, 8, 9 respectively to the subject code.

Course Name : All Branches of Diploma in Engineering / Technology

Course Code : EJ/EN/ET/EX/EV/IC/IE/IS/MU/DE/ME/PG/PT/AE/CE/CS/CR/CO/CM/IF/ CW/EE/EP/EUCH/CT/PS/CD/ED/EI/CV/FE/IU/MH/MI/TX/TC/FG

Semester : Sixth for EJ/EN/ET/EX/EV/IC/IE/IS/MU/DE/ME/PG/PT/AE/CE/CS/CR/ CO/CM/IF/CW/EE/EP/EU/CH/CT/PS/TX/TC/FG and Seventh for MH/MI/CD/ED/EI/ CV/FE/IU

Subject Title : Management

Subject Code : 17601

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	--	1&½	50#*	--	--	--	50

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

Management concepts are universal and it is a multidisciplinary subject. They are equally applicable to different types industries like Manufacturing, Service and Trade as well as different kind of business activities like industry, army, school, hospital, retail shops etc. Also, at the end of diploma course polytechnic students are expected to enter in to the Industrial Environment. This environment is altogether different and new to the students. A proper introduction and understanding of management fundamentals is therefore essential for all these students.

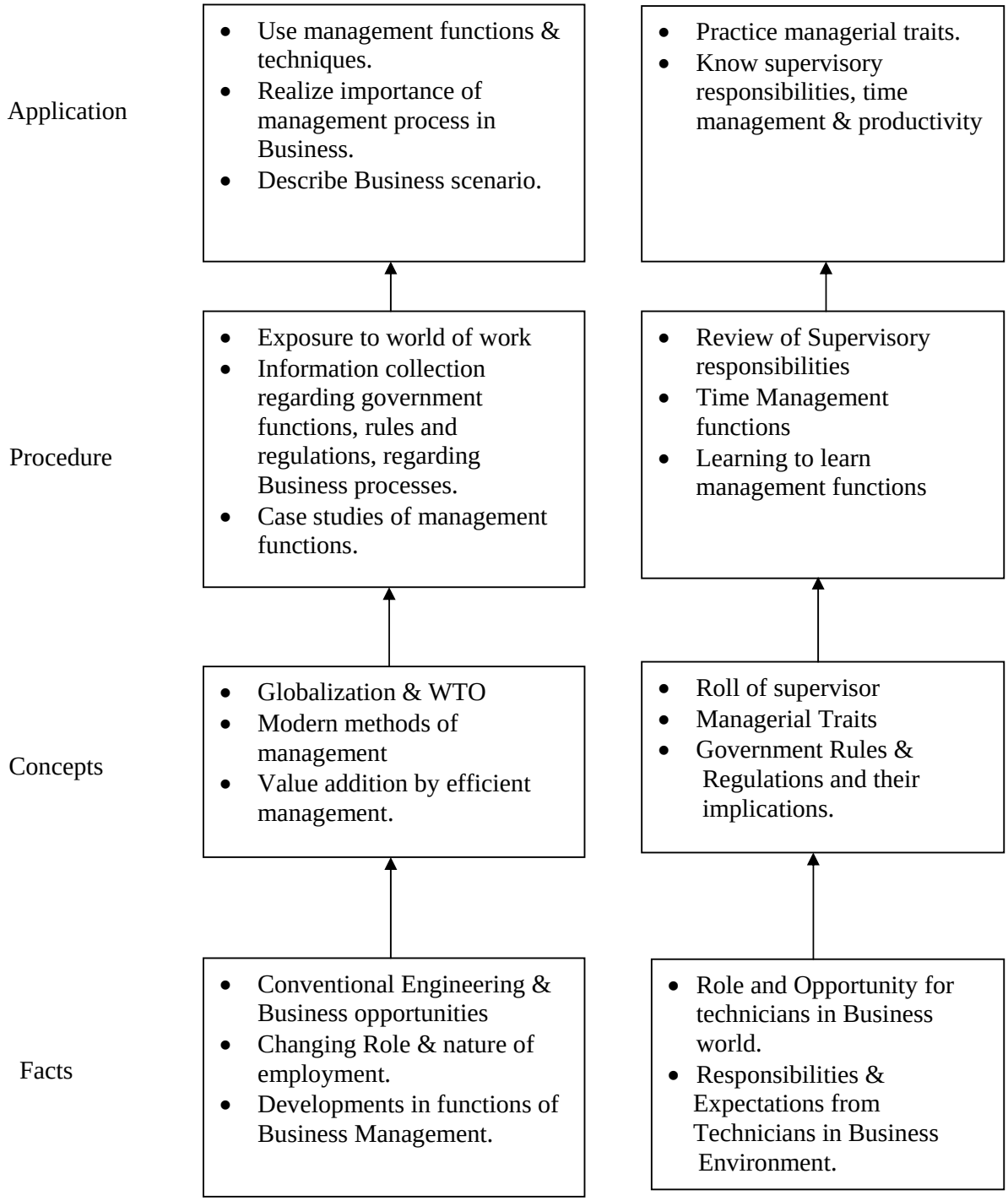
Contents of the this subject will enable the students to address various issues related to human resource, finance, materials, legislations etc. by use of basic principles of management. This will ensure that students will play their role effectively to enhance the quality of business output in total.

Objective:

The students will able to:

1. Get familiarized with environment related to business processes.
2. Know the management aspects of the organisations.
3. Understand Role & Responsibilities of a Diploma engineer.
4. Understand importance of quality improvement techniques.
5. Appreciate need and importance of safety in industries.
6. Understand process of Industrial finance and its management.
7. Know the latest trends in industrial management.

Learning Structure:



Contents: Theory

Topic and Contents	Hours	Marks
Topic 1: Overview of Business **Specific Objectives** ➢ State various business types and sectors ➢ Describe importance of globalisation 1.1. Types of Business • Service • Manufacturing • Trade 1.2. Industrial sectors Introduction to • Engineering industry • Process industry • Textile industry • Chemical industry • Agro industry • IT industry • Banking, Insurance, Retail, Hospitality, Health Care 1.3 Globalization • Introduction • Advantages & disadvantages with respect to India	02	04
Topic 2: Management Process **Specific Objectives** ➢ State various management principles ➢ Describe different management functions 2.1 What is Management? • Evolution • Various definitions of management • Concept of management • Levels of management • Administration & management • Scientific management by F.W.Taylor 2.2 Principles of Management (14 principles of Henry Fayol) 2.3 Functions of Management • Planning • Organizing • Directing • Controlling • Decision Making	08	08
Topic 3: Organisational Management **Specific Objectives** ➢ Compare different forms of organisation , ownership for a specific business ➢ Describe types of departmentation 3.1 Organization : • Definition	08	08

• Steps in organization 3.2 Types of organization • Line • Line & staff • Functional • Project 3.3 Departmentation • By product • By process • By function 3.4 Principles of Organisation • Authority & Responsibility • Span of Control • Effective Delegation • Balance ,stability and flexibility • Communication 3.5 Forms of ownership • Proprietorship • Partnership • Joint stock • Co-operative Society • Govt. Sector		
Topic 4: Industrial Safety and Legislative Acts **Specific Objectives** ➢ Describe types of accidents & safety measures ➢ State provisions of industrial acts. 4.1 Safety Management • Causes of accidents • Types of Industrial Accidents • Preventive measures • Safety procedures 4.2 Industrial Legislation - Necessity of Acts Important Definitions & Main Provisions of following acts: • Indian Factory Act • Workman Compensation Act • Minimum Wages Act	08	06
Topic 5: Financial Management (No Numerical) **Specific Objectives** ➢ Explain functions of financial management ➢ State the sources of finance & types of budgets. ➢ Describe concepts of direct & indirect taxes. 5.1 Financial Management- Objectives & Functions 5.2 Capital Generation & Management • Types of Capitals - Fixed & Working • Sources of raising Capital - Features of Short term, Medium Term & Long Term Sources 5.3 Budgets and accounts • Types of Budgets	08	08

• Fixed & Variable Budget - Concept • Production Budget - Sample format • Labour Budget - Sample format • Profit & Loss Account & Balance Sheet - Meaning, sample format, meaning of different terms involved. 5.4 Meaning & Examples of - • Excise Tax • Service Tax • Income Tax • Value Added Tax • Custom Duty •		
Topic 6: Materials Management (No Numerical) **Specific Objectives** ➢ Describe concept of inventory, ABC analysis & EOQ. ➢ Describe purchase functions & procedures ➢ State features of ERP & MRP 6.1. Inventory Concept, its classification, functions of inventory 6.2 ABC Analysis - Necessity & Steps 6.3 Economic Order Quantity Concept, graphical representation, determination of EOQ 6.4 Standard steps in Purchasing 6.5 Modern Techniques of Material Management • Material Resource Planning (MRP) - Functions of MRP, Input to MRP, Benefits of MRP • Enterprise Resource Planning (ERP) - Concept, list of modules, advantages & disadvantages of ERP	08	08
Topic 7: Quality Management **Specific Objectives** ➢ State Principles of Quality Management ➢ Describe Modern Technique & Systems of Quality Management 7.1 Meaning of Quality Quality Management System - Activities, Benefits Quality Control - Objectives, Functions, Advantages Quality Circle - Concept, Characteristics & Objectives Quality Assurance – Concept, Quality Assurance System 7.2 Meaning of Total Quality and TQM Components of TQM – Concept, Elements of TQM, Benefits 7.3 Modern Technique & Systems of Quality Management like Kaizen,5'S',6 Sigma 7.4 ISO 9001:2000 - Benefits, Main clauses.	06	08
Total	**48**	**50**

Learning Resources:
Books:

Sr. No	Author	Name of Book	Publisher
01	Dr. O.P. Khanna	Industrial Engineering & Management	Dhanpat Rai & Sons New Delhi
02	Banga & Sharma	Industrial Engineering & Management	Khanna Publication
03	Dr. S.C. Saksena	Business Administration & Management	Sahitya Bhavan Agra
04	W.H. Newman E. Kirby Warren Andrew R. McGill	The process of Management	Prentice- Hall

E Source:

- nptel.iitm.ac.in
- http://iete-elan.ac.in/subjects/amIndustrialMgmt.htm

Course Name : Mechanical Engineering Group

Course Code : ME/MH/MI/PG/PT

Semester : Sixth for ME/PG/PT and Seven for MH/MI

Subject Title : Industrial Fluid Power

Subject Code : 17608

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	02	03	100	--	25#	25@	150

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

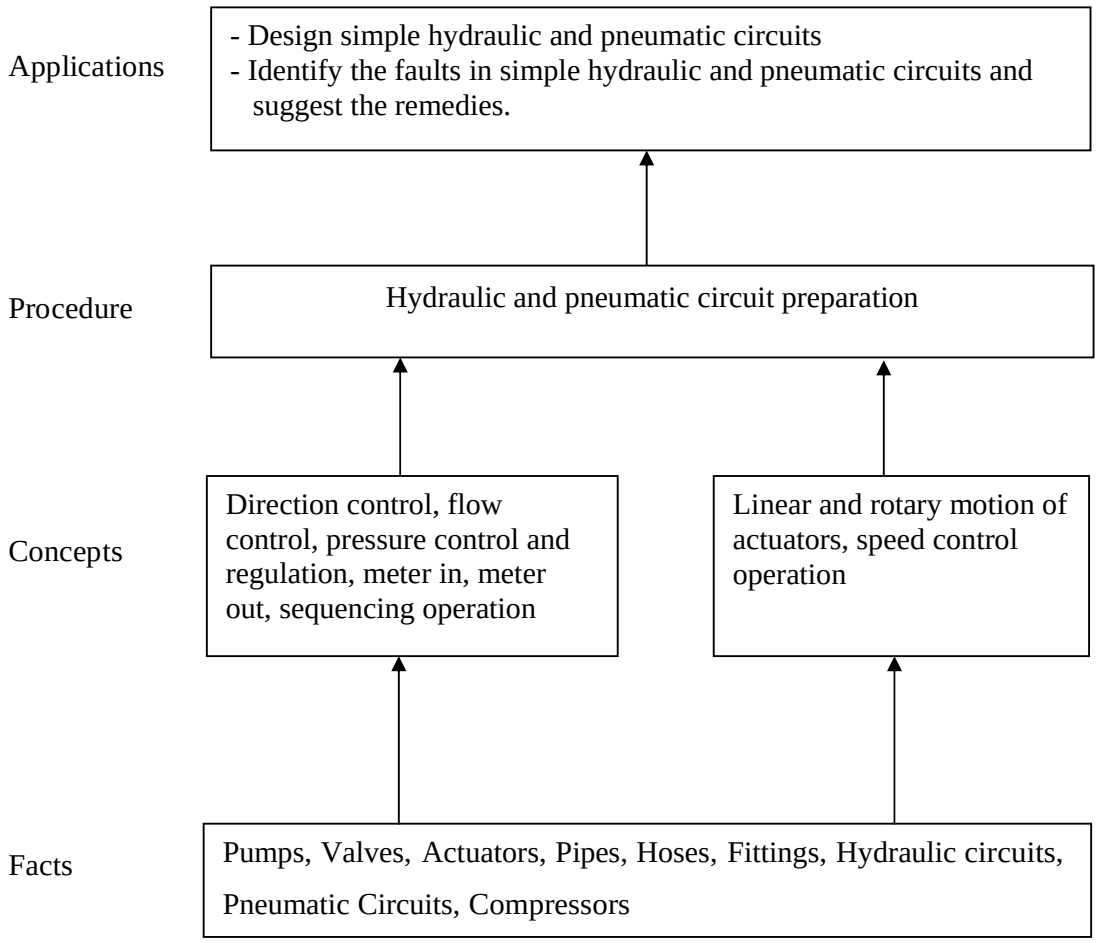
Rationale:

Oil hydraulic systems & pneumatic systems are widely used in all fields of engineering as clean source of motive power. Low cost automation systems with the use of pneumatics have become popular as manufacturing aids. Diploma engineers come across such systems in all the segments of industries. This subject will give the students, the basic skills and knowledge of oil hydraulics and pneumatics which will be directly needed in the industrial environment.

General Objectives: The student will be able to

1) Identify various components of hydraulic & pneumatic systems.
2) Know the working principle of various components used in hydraulic & pneumatic systems.
3) Select appropriate components required for simple hydraulic and pneumatic circuits.
4) List the probable causes of faults or defects in the hydraulic & pneumatic circuits.

Learning Structure:



Theory:

Topic & Content	Hours	Marks
Topic 1. Basics of Oil Hydraulic Systems Specific Objectives: ➢ Identify various components in simple oil hydraulic circuits. ➢ List the types of various components in simple oil hydraulic circuits. ➢ Explain the construction and working principle of various components in simple oil hydraulic circuits. Contents • General layout, Applications, Merits and limitations of oil hydraulic systems **06 Marks** • Overview of essential properties of oils used in oil hydraulic circuits **06 Marks** • Construction, working principle, applications and symbols of Vane pump, gear pump, Gerotor pump, screw pump, piston Pump **12 Marks**	16	24
Topic 2. Hydraulic Valves, Actuators and Accessories ➢ Select valves, actuators and accessories for the given application of hydraulic circuit. • **Valves** **12 Marks** Construction, principle of working and symbols of Pressure control valves - pressure relief valve - direct, pilot operated , pressure reducing, pressure unloading, Sequence valves, counter balancing Direction control valves - Poppet valve, spool valve, 2/2, 3/2, 4/2, 5/3, methods of actuation. Types of different center positions. check valves, pilot operated check valves Flow control valves - pressure compensated, non pressure compensated flow control valve, • **Actuators** **06 Marks** Classification of actuators Construction, working principle and symbols of Rotary Actuators - Hydraulic motors Linear Actuators - Cylinders - single acting, double acting, and their subtypes. Different mounting methods. • **Accessories** **06 Marks** Construction, working principle and symbols of Pipes, Hoses, Fittings, Oil filters, Seals and gaskets, Accumulators	18	24
Topic 3. Oil Hydraulic Circuits Specific Objectives: ➢ Draw layout of oil hydraulic circuits. ➢ Explain working of oil hydraulic circuits. ➢ Develop oil hydraulic circuit for different applications. Contents: • 'Meter in' ,'Meter out', 'Bleed off', Unloading , two cylinder synchronizing, regenerative, counterbalance , dual pump unloading circuits.	08	12

• Sequencing circuit – time dependent and pressure dependent • Oil hydraulic circuits for milling machine, shaper machine,		
Topic 4. **Introduction to and Components of Pneumatic Systems** Specific Objectives: ➢ Identify various components in simple pneumatic circuits. ➢ List the types of various components in simple pneumatic circuits. ➢ Explain the construction and working principle of various components in simple pneumatic circuits. Contents: • Introduction **06 Marks** Applications of pneumatic systems General layout, merits and limitations of pneumatic systems Selection of air compressors for pneumatic circuits • Valves **08 Marks** Construction, principle of working and symbols of Pressure regulating valves, Direction control valves, Flow control valves • Actuators **06 Marks** Construction, working and symbols of Rotary Actuators - Pneumatic motors Linear Actuators – Cylinders - single acting, double acting. • Accessories **04 Marks** Construction, working and symbols of Pipes, Hoses, fittings, FRL unit	14	24
Topic 5. **Pneumatic Circuits** Specific Objectives: ➢ Draw layout of simple pneumatic circuits. Contents: • Speed control circuits for double acting cylinder and bidirectional air motor **08 Marks** • Sequencing circuits - Position based sequencing circuit and time delay circuit **08 Marks**	08	16
Total	**64**	**100**

Practical:

Skills to be developed:

Intellectual Skills:

1. Prepare simple oil hydraulic & pneumatic circuits.
2. Compare the performance of oil hydraulic & pneumatic systems.
3. Identify the faults & suggest remedies in oil hydraulic & pneumatic circuits.
4. Select proper circuit for given application.

Motor Skills:

1. Connect different components in oil hydraulic or pneumatic circuit as per given drawing.
2. Perform repairing and / or replacement of defective components in the oil hydraulic or pneumatic circuit.
3. Draw the oil hydraulic and pneumatic circuits using symbols.

List of Practicals:

1. Assemble meter in and meter out oil hydraulic circuits and compare its working. List the applications
2. Assemble sequencing circuit and list its applications.
3. Assemble quick return mechanism oil hydraulic circuit for shaper machine.
4. Assemble pneumatic circuit for speed control of double acting cylinders.
5. Assemble pneumatic circuit for speed control of pneumatic motor and measure the speed of motor.
6. Study of trouble shooting procedures of various hydraulic and pneumatic circuits.
7. Selection of circuit components for simple oil hydraulic circuits such as circuits used for milling machine, shaper machine.

[Note - Term work shall consist of circuit diagram with ISO symbols, specifications and brief write up for all the above practicals. For practical no 1 - 5, the practical batch size shall be divided in two groups.]

Assignments -

1) Market survey of oils used for oil hydraulic circuits - collection of name of manufacturers, detailed technical specifications, trade names, costs, packing sizes
2) Study of any one mobile hydraulic system such as in earth moving equipments or any one stationary hydraulic system such as in any machine tool and its detailed report.
3) Study of any pneumatic circuit such as circuits used in special purpose machines, low cost automation systems, material handling systems and its detailed report.

[Assignments to be completed in a group of (max.) four students.]

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher
01	Majumdar S.R	Oil Hydraulic system- Principles and maintenance	Tata McGraw Hill
02	Majumdar S.R	Pneumatics Systems Principles and Maintenance	Tata McGraw Hill
03	Joji B.	Pneumatic Controls	Wiley India Pub.
04	Stewart	Hydraulics and Pneumatics	Taraporewala Publication

2. Catalogues:

Various system components' manufacturers' catalogues.

3. CDs:

CDs developed by various system components' manufacturers

Course Name : Mechanical Engineering Group

Course code : ME/PG/PT/MH/MI/FE/FG

Semester : Sixth for ME/PG/PT/FG and Seventh for MH/MI/FE

Subject Title : Production Engineering & Robotics

Subject Code : 17609

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
04	--	--	03	100	--	--	--	100

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

This subject is technology subject. A technician is required to work at the highest productivity level. His /her productivity depends on the productivity of two important resources i.e. human resource and equipment resource in the manufacturing system. Hence he/she should learn the techniques for improvement in productivity of these two resources.

A technician is required to plan the production schedule. He / She is required to organize material supply for the manufacturing activities. The total cost of goods produced contains expenditure incurred on material and human resources. The direct and indirect cost of scarce resources can be reduced by the technician by optimizing their use. . Hence he / she should learn, process planning, production planning and control.

Modern manufacturing system employs latest techniques such as JIT, TPM, FMS, 5'S', Kaizen. To keep pace with time, the technician should know all these techniques.

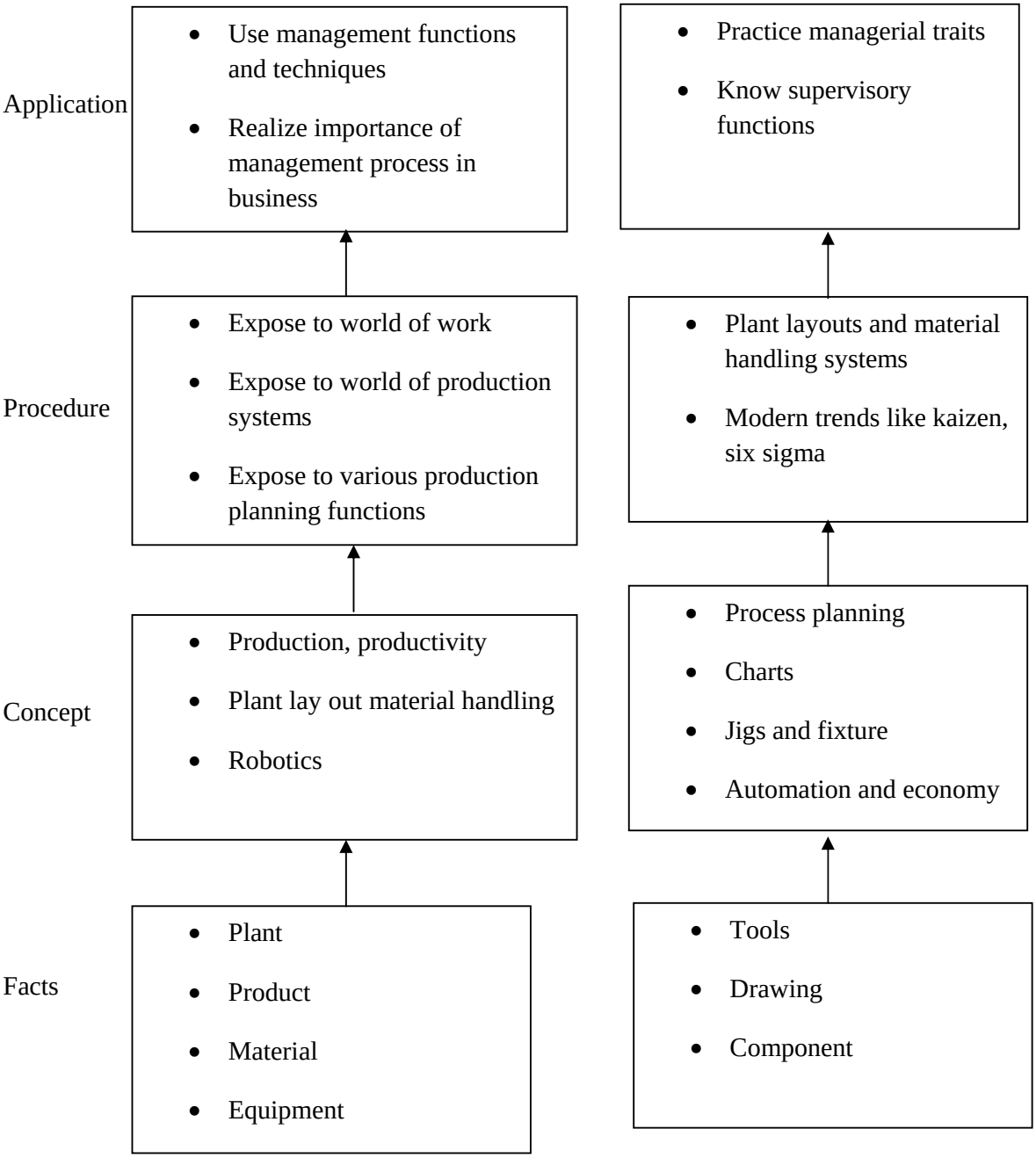
Industrial Robots are going to perform important and difficult functions in modern production system. A technician is expected to be aware of robots and their functioning.

General Objectives:

Students will be able to;

1. Understand importance of productivity and factors for improvement of productivity.
2. Know different production systems and modern trends in manufacturing systems.
3. Apply modern tools in production engineering like six sigma, kaizen, poka yoke, etc.
4. Understand concept of robotics, limitations of human in difficult operation and applications of robots.

Learning Structure:



Theory:

Topic and Content	Hrs.	Marks
Topic 1. Production System **Specific Objectives:** ➢ Define productivity ➢ State methods to improve productivity **Content:** 1.1 Production - definition ,types of production systems **04 Marks** 1.2 Productivity - importance, measurement of productivity, techniques of improving productivity. **04 Marks**	06	08
Topic 2. Plant Location, Plant Layout and Material Handling **Specific Objectives:** ➢ Draw layouts for manufacturing unit. ➢ State principles of material handling. ➢ Correlate plant layout and material handling. **Content:** 2.1 Plant Location - Importance of site selection, factors affecting site selection, Government policies, relaxation for backward areas. **04 Marks** 2.2 Plant Layout - objectives, types, design principles, characteristics of plant layout, symptoms of bad plant layout. **04 Marks** 2.3 Material handling - need, principles and types of material handling devices - conveyor, hoist & crane, forklift truck, trolley, pipe, selection of material handling systems and devices**.** Automated Guided Vehicles **06 Marks**	10	14
Topic 3. Process Planning **Specific Objectives:** ➢ Prepare process sheet for any given component. ➢ Select machine tool for given manufacturing process. **Content:** 3.1 Planning of processes from raw material to finished product, factors affecting process planning, **08 Marks** 3.2 Deciding sequence of operations, operation sheet, combined operations, and determination of inspection stages. **08 Marks**	10	16
Topic 4. Production Planning and Control (PPC) **Specific Objectives:** ➢ State importance of PPC system in industry. ➢ Describe techniques of production control. **Content:** 4.1 Definition ,functions and importance of PPC, Meaning of Control, Progressive Control **06 Marks** 4.2 Gantt chart, Flow Process Sheet, Line balancing, **06 Marks**	06	12
Topic 5. Work Study **Specific Objectives:** ➢ Calculate standard time for given activity ➢ Prepare process chart **Content:** 5.1 Method Study- Definition, Objectives, Procedure, Selection of	08	12

work. **04 Marks** 5.2 Recording Techniques:- Process Charts - Outline process chart, Flow process chart, Two Handed process chart, Multiple activity Chart, Flow diagram, String diagram, Travel chart. **04 Marks** 5.3 Work Measurement **–** Objectives, procedure, Time Study, Time Study Equipments. Stop Watch Time Study, Allowances, Calculation of Standard Time, **04 Marks**		
Topic 6. Jigs and Fixtures **Specific Objectives:** ➢ Understand importance and use of jigs and fixtures in industries ➢ Understand principles of jig and fixture design and design a jig/fixture for given component **Content:** 6.1 Introduction. Difference between jig and fixture, Different components of Jig/ fixture, Types of jigs and fixtures. **04 Marks** 6.2 Types of locators and clamping devices, 3-2-1 principle of location, Fool proofing of jigs and fixture, General principles of jig and fixture design. **08 Marks**	08	12
Topic 7. Modern Trends in Production Engineering **Specific Objectives:** ➢ Describe kaizen technique. **Content:** 7.1 Just In Time manufacturing - Pull and push types of manufacturing systems. Waste management technique, Concept of ERP. **06 Marks** 7.2 Basic concepts of ➢ Kaizen ➢ Concept and meaning of 5S ➢ Lean manufacturing **04 Mark**	06	10
Topic 8. Robotics **Specific Objectives:** ➢ State concept of robotics ➢ State limitations of human in difficult operation ➢ State applications of robots. **Contents:** 8.1 Robotics - Introduction, Robot anatomy and structure, specification, working and basic components, Various configuration, Degree of freedom and application**.** **04 Marks** 8.2 Sensors - Classification, Basic configuration. **04 Marks** 8.3 Power sources for robotics, Actuators - Mechanical, Electrical, Hydraulic, and Pneumatic. **04 Mark**s 8.4 Concept of grippers – Screw and vacuum actuated gripper, end effectors. **04 Marks**	10	16
Total	**64**	**100**

Learning Resources:
Books:

Sr. No.	Author	Name of Book	Publication
1	L.C. Jhamb	Industrial Management	Everest
2	James C. Rigs	Production System, Planning, Analysis & Control	N.Y.Wiley & Sons
3	O.P. Khanna	Industrial Engineering and Management	Dhanpat Rai & Sons
4	P. H. Joshi	Jigs & Fixtures	Tata McGraw Hill
5	Taiichi Ohno	Toyota Production system	Productivity Press
6	Richard D.Klafter Michael Negin	Robotic Engineering	P.H.I
7	C.Ray Asfahl	Robots and Manufacturing Automation	John Wiley and Sons.
8	R.K. Rajput	Robotics & industrial Automation	S Chand.

Course Name : Diploma in Mechanical Engineering

Course code : ME/MH/MI

Semester : Sixth for ME and Seventh for MH/MI

Subject Title : Design of Machine Elements

Subject Code : 17610

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
04	--	02	04	100	--	25#	25@	150

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

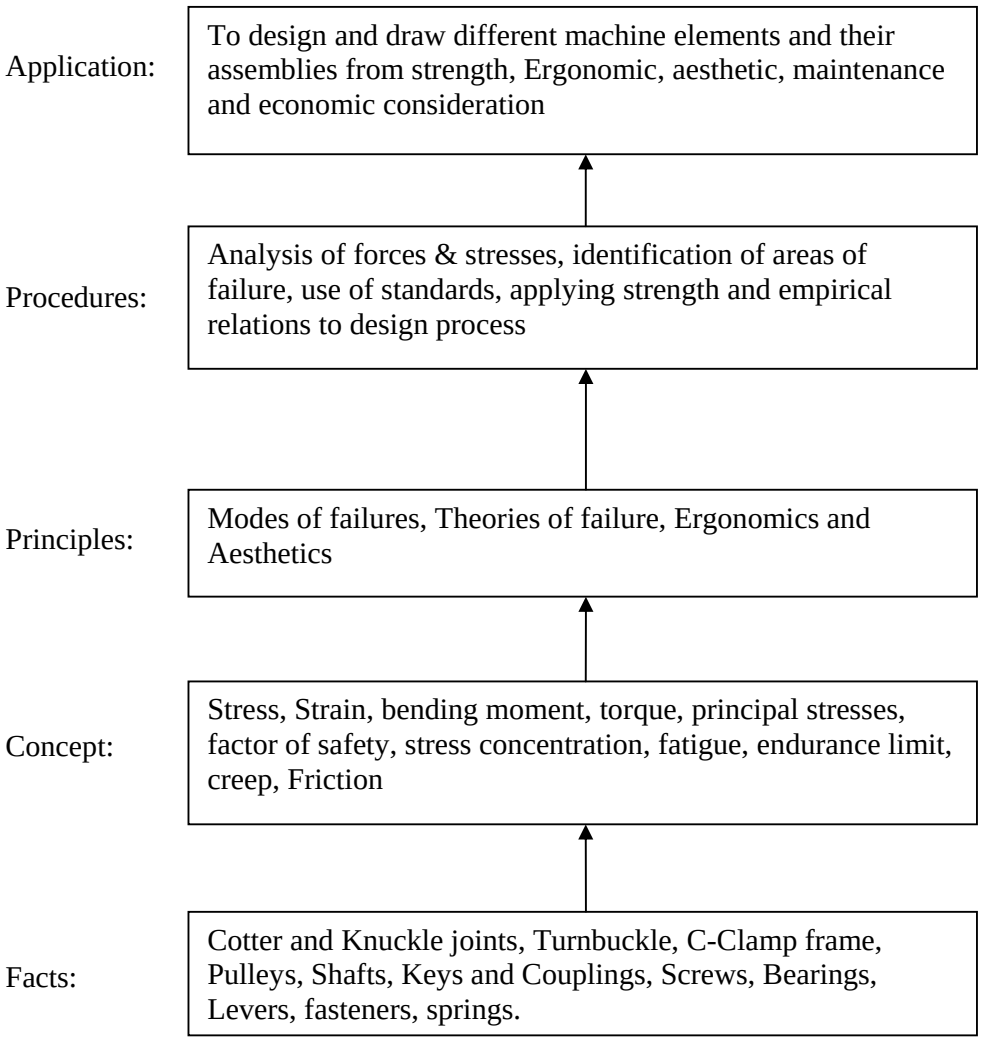
It is an applied technology subject. A diploma holder in mechanical discipline, is expected to design and draw simple machine components used in industries. Fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machines is essential. Subject aims at developing analytical abilities to give solutions to engineering design problems.

Objectives:

The student will be able to:

1. Analyze the various modes of failure of machine components under different load patterns.
2. Design and prepare part and assembly drawings.
3. Use design data books and different codes of design.
4. Select standard components with their specifications from manufacturer's catalogue.
5. Develop drawings on CAD software.

Learning Structure:



Contents: Theory

Topic and content	Hours	Marks
Topic 1: Introduction to Design Specific Objectives: ➢ State the need for the design ➢ List all parameters related to design ➢ Apply basic concepts in design procedure **1.1 Basic Design Considerations 04 Marks** • Design philosophy and Procedures • General Considerations in Design • Types of loads, concepts of stress ,strain, Stress – Strain Diagram for Ductile and Brittle Materials, Types of Stresses such as Tension, Compression, Shear, Bearing pressure Intensity, crushing, bending and torsion, Principle Stresses (Simple Numericals) • Concept of Creep, Fatigue, S-N curve, Endurance Limit. **1.2 Factors in Design 04 Marks** • Factor of Safety and Factors affecting its selection • Stress Concentration – Causes & Remedies • Converting actual load or torque into design load/torque using design factors **1.3 Properties of Engineering materials 04 Marks** • Designation of materials as per IS and introduction to International standards, advantages of standardization, use of design data book, use of standards in design and preferred numbers series. **1.4 Theories of Elastic Failures 04 Marks** • Principal normal stress theory, Maximum shear stress theory & maximum distortion energy theory. **1.5 Modern Design considerations 04 Marks** • Design for safety, Ecology, societal consideration & Concept of Product Design, System Design & Creativity in Design, Ergonomics and aesthetic considerations in design	12	20
Topic 2: Design of Joints, Levers & Offset Links Specific Objectives: ➢ Design a joint for a given load to be transmitted ➢ Calculate dimensions of lever/link using allowable bending and shear stress **2.1** Design of Cotter Joint, Knuckle Joint, Turnbuckle **06 Marks** **2.2** Design of Levers:- Hand/Foot Lever & Bell Crank Lever, **06 Marks** Lever for lever safety valve, Design of Off-set links, C - Clamp, Overhang Crank.	08	12

Topic 3. Design of Shafts, Keys and Couplings Specific Objectives: ➢ Design the diameter of a shaft on the basis of equivalent twisting/bending moment and allowable shear stress ➢ Design the section of most commonly used rectangular key on the basis of torque transmitted, allowable shear stress and crushing stress ➢ Design a rigid/flexible coupling for connecting two shaft on the basis of torque and allowable shear stress ➢ Design spur gear by taking into account effective tooth load **3.1 Design of shaft** **06 Marks** • Types of Shafts, Shaft materials, Standard Sizes, • Design of shafts (Hollow and Solid) using strength and rigidity criteria, • ASME code of design for line shafts supported between bearings with one or two pulleys in between or one overhung pulley **3.2** Design of key **04 Marks** • Types of keys • Design of rectangular, parallel sunk keys, • Effect of Keyways on strength of shaft. **3.3** Design of Couplings **06 Marks** • Flanged couplings – unprotected and protected types • Bush-pin type flexible coupling. **3.4** Design of spur gear **08 Marks** • Lewis equation for static beam strength of spur gear teeth • Power transmission capacity of spur gears in bending • Gear tooth failure modes – Scoring, scuffing Pitting & Teeth Breakage	14	24
Topic 4: Design of Power Screws Specific Objectives: ➢ Draw the different thread profiles used in power screws and state their merits and demerits ➢ Bring out the difference between self locking and overhauling ➢ Design the screw jack/toggle jack under a given loading conditions. **4.1 Basic concepts** Thread Profiles used for power Screws, relative merits and demerits of each, Self locking and overhauling properties Torque required to overcome thread friction, efficiency of power screws, types of stresses induced. **06 Marks** **4.2** Design of Screw Jack, Toggle Jack (only screw and nut). **06 Marks**	10	12
Topic 5: Design of springs Specific Objectives: ➢ Classify the springs on the basis of different criteria ➢ Design Helical spring based on given load conditions **5.1** Classification and Applications of Springs, Spring - terminology, materials specifications. Stresses in helical tension and compression springs, Wahl's correction factor, Deflection of springs, Energy stored in springs**.** **04 Marks** **5.2** Design of Helical tension and compression springs subjected to concentric applied loads like I.C. engine valves, weighing balance, railway buffers	08	12

and governor springs. **06 Marks** **5.3** Leaf springs - construction and applications **02 Marks**		
Topic 6: Design of Threaded and Welded Joints Specific Objectives: ➢ State the applications of fasteners ➢ Design threaded/welded joints under different load conditions **6.1** Stresses in Screwed fasteners, bolts of Uniform Strength, Design of Bolted Joints subjected to eccentric loading**.** **06 Marks** **6.2** Design of parallel and transverse fillet welds, axially loaded symmetrical section, Merits and demerits of screwed and welded joint **06 Marks**	08	12
Topic 7: Antifriction Bearings Specific Objectives: ➢ Classify the bearings ➢ Select rolling bearings, for specific applications, using manufacturers catalogue. Classification of Bearings – Sliding contact & rolling contact. Terminology of Ball bearings – life load relationship, basic static load rating and basic dynamic load rating, limiting speed. Selection of ball bearings using manufacturer's catalogue.	04	08
Total	**64**	**100**

Skills to be developed in Practicals

Intellectual Skills:

1. Understand the basic philosophy and fundamentals of Machine Design.
2. Apply and use the basic knowledge of earlier subjects like mechanical Engineering materials, strength of materials and theory of machines.
3. Analyze and evaluate the loads, forces, stresses involved in components and subassemblies and decide the dimensions.
4. Understand the modes of failures of m/c components and decide the design criteria and equations.
5. Understand the concept of standardization and selecting standard components.
6. Understand the methods of computer aided design practices.
7. Use of different design data books and IS codes.

Motor Skills:

1. Draw the components assembly as per the designed dimensions.
2. Modify drawings and design as per requirement.
3. Use the different design software.

List of Practicals:

1. Analyse the various modes of failure of machine components under different load patterns
2. Understand different codes used for design of machine elements.
3. Select the material for given applications using design data book.
4. Design and draw mechanical joints for given load.
5. Design and draw mechanical levers for given load.
6. Design project - 1
   Design and prepare the drawing on drawing sheet of transmission systemby observing transmission of power through shaft, keys, coupling, pulley and belt drive etc.
7. Design project - 2

Design and prepare the CAD drawing of transmission system by observing transmission of power through Power screw.

8. Design of springs.
9. Design of fasteners.

Learning Resources:

1. Books:

Sr. No.	Title	Author	Edition	Publisher
1	Machine Design	RS Khurmi and Gupta	14th	S. Chand
2	Machine Design	VB Bhandari	3rd	Tata McGraw Hill
3	Machine Design	U C Jindal	2 reprint	Pearson Education India
4	Mechanical Engg. Design	Richard G Budynas,J. Keith Nisbett	9th	Tata McGraw Hill
5	Theory and problems of Machine Design	Hall,Holowenko, Laughlin	Reprint 2005	McGraw Hill
6	Design Data Book	PSG	8th	PSG College of Technology Coimbatore
7	Fundamentals of Machine Components Design	Robert C.Juvinall Kurt M Marshek	3rd	Wiley India Edition

2. IS Codes:

1) IS 4218: 1967 ISO Metric Threads
2) IS 2693: 1964 Cast Iron Flexible Couplings
3) IS 2292: 1963 Taper keys & Keyways
4) IS 2293: 1963 Gib Head Keys & Keyways
5) IS 2389: 1963 Bolts, Screws, Nuts & Lock Nuts
6) IS 4694: 1968 Square threads
7) IS 808: 1967 Structural Steel
8) SKF Catalogue for Bearings

Course Name : Mechanical Engineering Group

Course Code : ME/MH/MI

Semester : Sixth for AE/ME and Seventh for MH/MI

Subject Title : Renewable Energy Sources & Management (Elective)

Subject Code : 17611

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

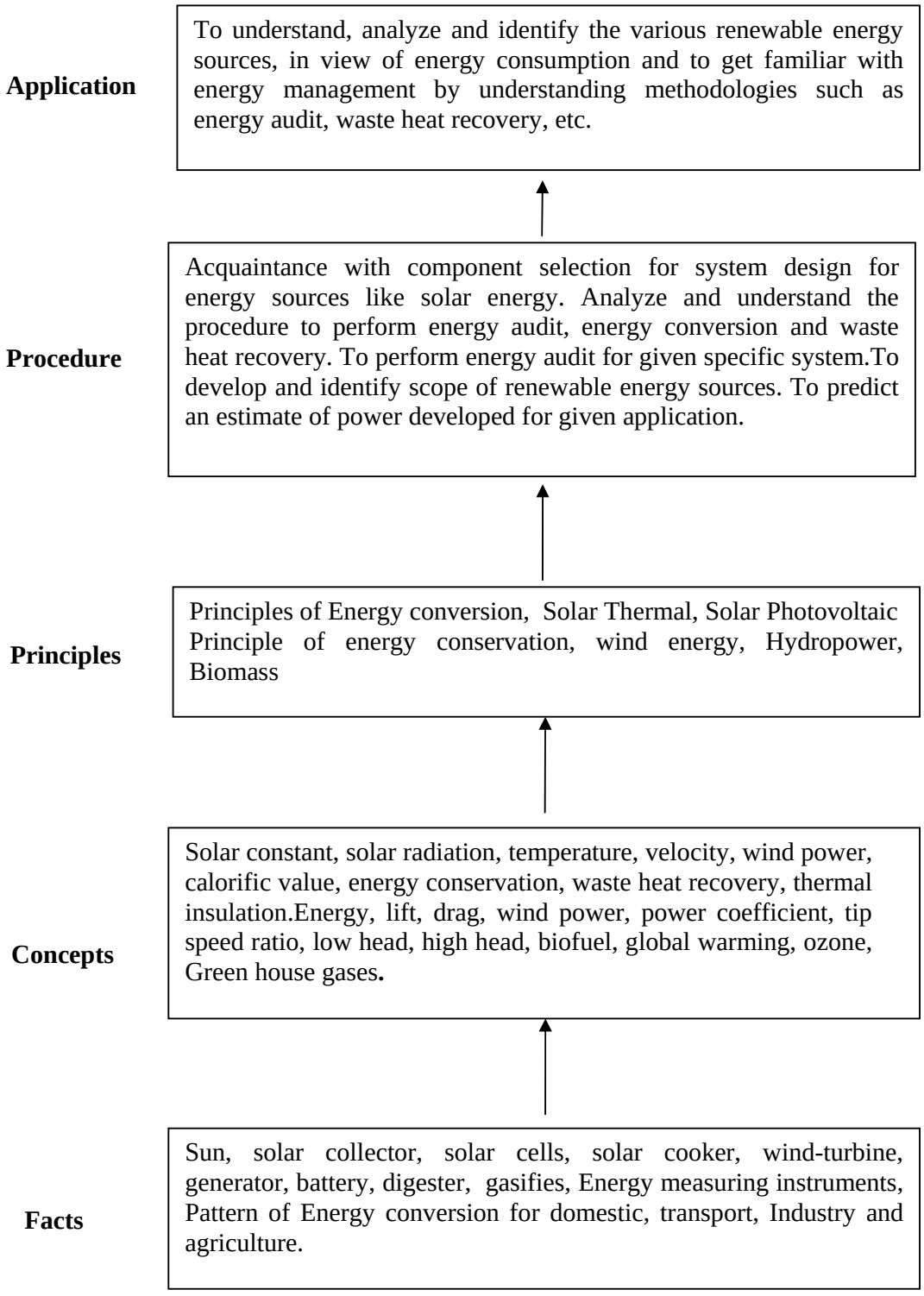
Energy is an important aspect in all sectors of country's economy. India as a country suffers from significant energy deficiency. The per-capita energy consumption, while increasing progressively, is significantly below global averages and in many instances below developing country averages. Increasing energy demands, shortage of fossil fuels, and the continuous increase in the level of green house gas emissions are the main driving forces to utilize various sources of renewable energy. The subject aims at enabling the students to know the basics of renewable energy, energy conversion, conservation, management techniques, energy audit and methodology.

General Objectives:

Student will be able to

1. Appreciate the need and importance of renewable energy
2. Analyze various Biomass Conversion processes.
3. Judge the Energy Saving Potential, Waste Heat Recovery, Energy Efficiency.
4. Understand the methodologies to execute preliminary energy audit.

Learning Structure:



Theory:

Topic & Content	Hours	Marks
Topic 1: Introduction – Renewable Energy Specific Objective ➢ Understand need of renewable energy ➢ Know the effect of use of fossil fuel on climate change and global warming ➢ Identify various renewable energy sources Contents: 1.1 Need of Renewable Energy 04 Marks Non renewable Energy sources - Fossil Fuels: Coal, Oil, Natural gas, Tar sands and Oil shale • Climate Change - Green House Gases, Global Warming • Sustainable growth • Present Energy Scenario: Global and Indian • Pattern of Energy Consumption. • Different types of Energy and its utilization. 1.2 Renewable Energy Sources: Classification and Introduction 08 Marks • Solar Energy - Direct Uses • Solar Thermal • Solar Photovoltaic • Solar Energy - Indirect Uses • Hydro-Power • Wind Power • Bio-Energy • Wave Power • Non-Solar Renewable Energy • Tidal Energy • Geothermal Energy. 1.3 Energy Storage Management 04 Marks • Thermal Storage-sensible and latent its comparison • Electrical Storage: Introduction to battery, super capacitor, and fuel cell.	07	16
Topic 2. Solar Energy – Direct Uses Specific Objective ➢ State the concept of solar radiation ➢ Describe the working principle of solar thermal systems ➢ Compare different solar photovoltaic system Contents: 2.1 Solar Radiation 08 Marks • Sun & Earth • Solar Spectrum • Sun & Earth Movement • Solar Geometry: Concept 2.2 Solar Thermal Applications & Its working Principles 04 Marks • Water Heating • Space Heating	15	28

• Space Cooling and Refrigeration • Power Generation • Distillation 1.3 Construction Details containing capacity, size and materials of: 06 Marks • Solar Flat Plate Collector • Solar Evacuated Flat plate Collector • Solar Concentrating Collector • Solar Cooker - Box and Concentrating • Solar Drying 2.4 Solar Photovoltaic Conversions: Principle of working of Solar cell 10 Marks • Construction Details containing capacity, size & materials of Solar Photovoltaic System Applications- Solar Lantern, Solar Home System, SPV Street Light, SPV Traffic Signal, Info - display, SPV Power Pack, Stand alone SPV Power Plant, Solar Generators, Building Integrated PV Systems, SPV Pumping Systems **(No derivations & numericals)**		
Topic 3. Solar Energy - Indirect Uses - I Specific Objective ➢ Know the site selection criteria for wind and hydro plant ➢ Classify small hydro plants ➢ Identify component of Horizontal Axis Wind Turbine Contents: 3.1 Hydro-Power 12 Marks • Site Selection • Different Components of Small Hydroelectric Projects • Types of Turbine – Francis, Propellor • Classification of Small Hydro-electric Plants: Ultra low head, Low head, Medium/high head, Micro hydro, Mini hydro, Small hydro 3.2 Wind Power 08 Marks • Concepts- Wind Energy Conversion, Lift and Drag, • Classification and Description • Components of Power Generating Horizontal Axis Wind Turbine • Site Selection Criteria.	08	20
Topic 4. Solar Energy – Indirect Uses - II Specific Objective ➢ State the site selection criteria for wind and hydro plant ➢ Compare bio fuels Contents: 4.1 Bio-Energy -Photosynthesis and Carbon Cycle Concept. 08 Marks • Bio energy Sources – Types Such as • Energy Plantation • Agricultural Crops • Wood Residues • Animal Waste • Municipal Solid Waste • Landfill Gas • Commercial and Industrial Waste 4.2 Biomass Conversion Routes- Thermo chemical Route and Biochemical Route 04 Marks	10	16

• Combustion • Gasification • Pyrolysis • Anaerobic digestion • Fermentation 4.3 Bio fuels from Bio-Mass 04 Marks • Bioethnol • BioDiesel • Biogas • Algae- A new biomass		
Topic 5: Energy Management Specific Objective ➢ Describe the methodology of execute preliminary energy audit ➢ Judge the energy saving potential, waste heat recovery, energy effect ➢ State the use of different energy measuring instruments Contents: 5.1 Definition, Objectives & Need of Energy Audit 06 Marks • Energy Audit: Types And Methodology • Preliminary Energy Audit Methodology 5.2 Energy Measurement and Instruments 08 Marks • Lux meters: • Pyranometer, • Sunshine Recorder • Pyrheliometer • Combustion analyzer: • Fuel Efficiency Monitor: • Fyrite • Contact thermometer: • Infrared Thermometer: • Pitot Tube and manometer: • Water flow meter: • Speed Measurements: • Leak Detectors: • Hand held meters and Power Analyzer to measure electrical parameters such as kVA, kW, PF, Hertz, kVAr, Amps and Volts. 5.3 Energy Conservation 06 Marks • Energy Efficiency - Boiler & Furnace Efficiency • Waste Heat Recovery Systems • Energy Loss Prevention - Thermal Insulation	08	20
Total	**48**	**100**

Note: Subject teachers are expected to give relevant information briefly on each of the above topic without analytical treatment.

Practicals:

Intellectual skills:

1) To identify concept, parts of devices etc.
2) To understand the construction and working principle of Renewable energy systems.
3) To know function, classification and discrimination of parts or equipments.

4) To know test procedure. Calculate and interpret test result.
5) To observe the faults and suggest the remedial action for repair and performance improvement.

Motor Skills:

1) Ability to observe / locate / operate various parts of instruments / equipments / tools.
2) Ability to accurately measure the various parameters.
3) Ability to follow the systematic procedure.
4) Ability to handle data and draw graphs.

List of Practical

Sr. No.	Name of Practical
1.	Collect information about global and Indian energy market from websites and prepare write up
2.	Visit to a commercial or Industrial Solar water heating Installation of atleast 500 liters per day capacity. Writing a report about collector layout, piping and fittings and measurement of performance of the system.
3.	Performance measurement of photovoltaic array used for an application such as pumping, home lighting etc. making use of energy instruments.
4.	Visit to or study of a Small Hydraulic Power plant.
5.	Performance estimation and comparison of different collector technologies used for hot water generation such as evacuated tube, flat plate collector, dish collector etc. on the experimental set up installed in the laboratory.
6.	Study construction and working of horizontal axis wind mill or to visit a nearest wind farm and write a report.
7.	Visits to a biogas plant or biomass gasification facility. Writing a report on plant structural details and components. Measurement of performance.
8.	Practical study of energy audit instruments used for measurement of electric energy, temperature, flow, exhaust gas analysis etc.
9.	Conducting walk through energy audit of a small establishment such as workshop/Office/Home/SSI unit.

Learning Resources:

1. Books:

Sr. No.	Author	Title	Publisher / Edition
1	Boyle Godfrey	Renewable Energy: Power For A Sustainable Future	Oxford University Press
2	S. P. Sukhatme	Solar energy, Principles of Thermal Collection & Storage	3rd Edition, Tata McGraw Hill
3	B. H. Khan	Non-Conventional Energy Resources	2nd Edition, McGraw Hill Companies
4	Chetan Singh Solanki	Solar Photovoltaics Fundamentals Technologies and Applications	PHI Learning private ltd N. Delhi

5	G. D. Rai	Non conventional energy sources	Khanna publication
6	---	Guide Book for National Certification for Energy Managers and Energy Auditors, Book 1 – General Aspects of Energy Management and Energy Audit	Bureau of Energy and Efficiency (BEE)

2. CD's / PPT's etc.:

1. CDs developed by Maharashtra Energy Development Agency (MEDA), Pune. (www.mahaurja.com)
2. Dr. Govind N. Kulkarni, Documentary (DVD), Solar Energy - An Awakening, Usha Solar

3. Websites

1. Website of Bureau of Energy and Efficiency. (www.bee-india.nic.in)
2. Website of Mahaurja- (www.mahaurja.com)
3. Energy management (www.energymanagertraining.com)
4. www.bp.com

Course Name : Diploma in Mechanical Engineering

Course Code : ME/MH/MI

Semester : Sixth for ME and Seventh for MH/MI

Subject Title : Refrigeration and Air Conditioning (Elective)

Subject Code : 17612

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25@	125

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

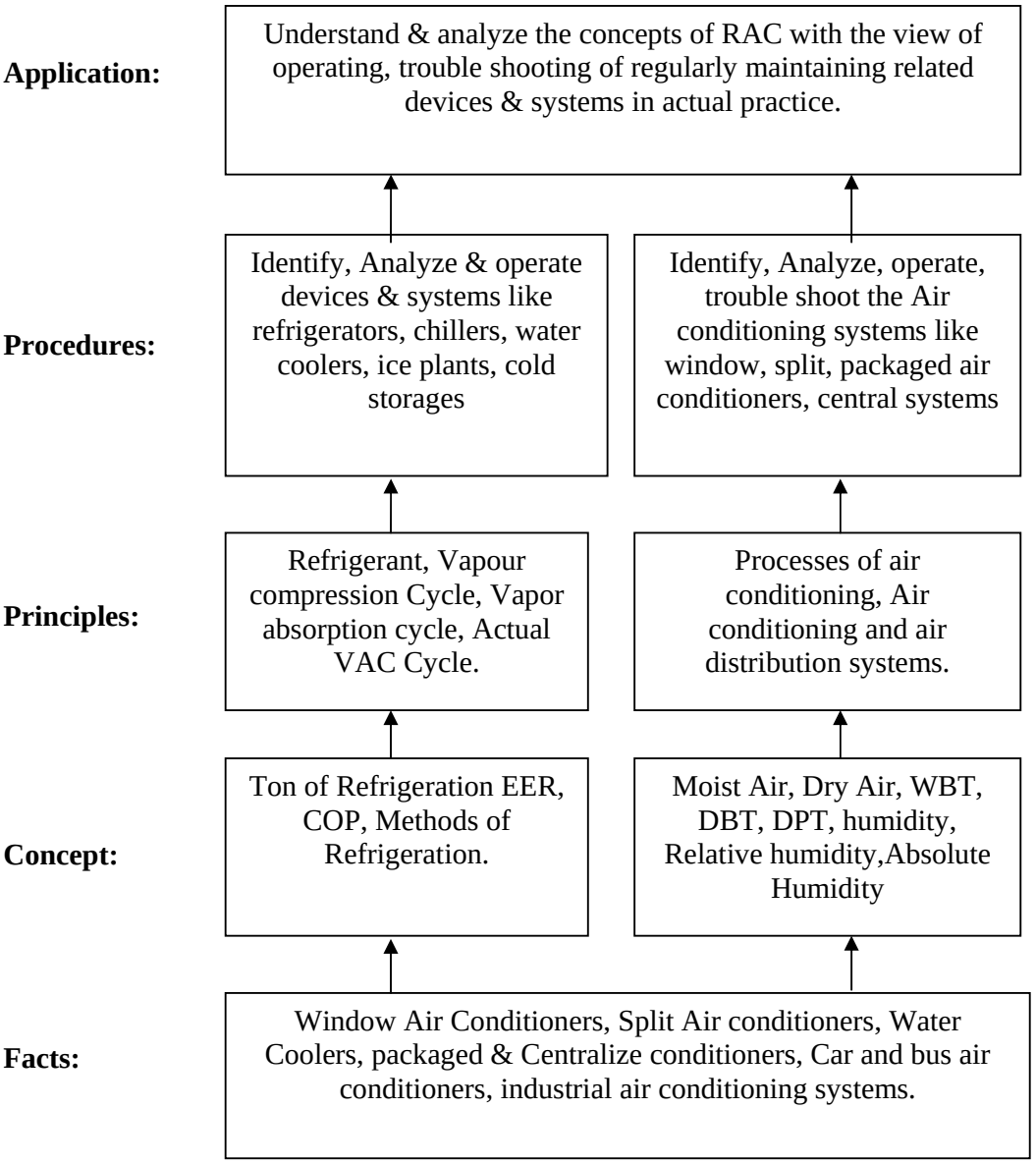
Refrigeration & Air conditioning has a wide application in varied areas of domestic, commercial and industrial applications. With advance in technology & development of new Refrigerants. Refrigeration & Air conditioning finds prominent positions from house hold applications like refrigerators, air conditioners to advance cryogenic systems maintaining subzero temperatures in industrial and Research areas. Air conditioning of building, industries, malls has also emerged as one of the most advanced areas of applications in this field. This field has a unique application potential in every sector. Refrigeration & Air conditioning is one of the most demanded job areas for diploma Engineers with a good scope for the self employment. Considering this, diploma Engineers should study and practically learn this subject in detail. They must know fundamentals, processes, system and applications of Refrigeration & Air conditioning. Practical skills in this areas like maintenances, fault handlings & repairs must also be acquired by diploma Engineers.

General objectives: After learning of this subject students should be able to

1) Compare various types Refrigeration cycles
2) List various properties of different refrigerants and appreciate applications of Refrigerants with their ill effects on environment.
3) Identity various compartment & controls used in Refrigeration & Air Conditioning practice.
4) Able to assemble, dismantle the components of refrigeration systems along with trouble shoot the refrigeration systems

5) Explain Psychometric properties and calculate various parameters
6) Explain various air conditioning systems of their applications.
7) Identify & locate different components of air conditioning & distribution systems.

Learning Structure:



Theory:

Topic & Content	Hours	Marks
Topic 1. Introduction to Refrigeration Specific Objectives: ➢ Define various terms related to refrigeration ➢ Explain various refrigeration cycles ➢ Explain properties and environmental effects of refrigerants Contents: 1.1 Introduction **06 Marks** Definition, Necessity of refrigeration, Concept of heat engine, heat pump and Refrigerator, Unit of refrigeration, C.O.P., EER and refrigerating effect, Non conventional methods of refrigeration like Vortex tube, Pulse tube refrigeration, solar refrigeration 1.2 Refrigerants: **06 Marks** Classification, Desirable Properties, selection& Nomenclature of refrigerants. Concept of Green House Effect, Ozone Depletion, Global warming. Concept of Ozone Depletion Potential (ODP) & Global Warming Potential (GWP) of different Refrigerants. Eco-friendly refrigerants like R-134a,Hydrocarbon refrigerants 1.3 Refrigeration Cycles **06 Marks** ➢ Reversed Carnot Cycle and its representation on PV and TS diagram. • Air Refrigeration Cycles - Bell Coleman air refrigerator • Representation on PV and TS diagram, Types and applications like aircraft refrigeration using simple air cooling system.	08	18
Topic 2. Vapour Compression and Absorption Systems Specific Objectives: ➢ Describe vapor compression and absorption systems. ➢ Calculate different parameters of vapor compression systems Contents: • Vapor Compression Cycle - Principle, components, Representation on P-H and T-S diagram, Effects of wet compression, dry compression. **06 Marks** • Calculation of COP, Effect of superheating, under cooling, suction pressure and discharge pressure, Actual V.C.C., (simple numerical), Methods of improving COP (No Numericals). Introduction to multistage V.C.C., its necessity, advantages. **06 Marks** • Vapor Absorption system-Principle, components and working of aqua- ammonia system (simple & practical), Li-Br Absorption System, Electrolux Refrigeration System (No Numericals) Comparison of above Refrigeration Cycles. **06 Marks**	08	18
Topic 3. Refrigeration System Equipments Specific Objectives: ➢ Identify refrigeration equipments in view of classification, construction and operation. ➢ List criterions of selection of equipments for various refrigeration systems	08	16

Contents: 3.1 Compressors: Classification, Construction and working of open type, Hermetic, centrifugal, rotary, screw and scroll compressor and their applications. Compressor for car air-conditioning system (Wobble plate type) **04 Marks** 3.2 Condensers: Classification Description of air cooled and water cooled condensers, Comparison and applications, Evaporative condensers **04 Marks** 3.3 Expansion devices: Capillary tube, Automatic exp valve, Thermostatic exp. valve, Applications **04 Marks** 3.4 Evaporators and chillers: Classification of evaporators, Construction and working of Bare tube, Plate surface, finned, shell and tube, flooded and dry expansion evaporator, Capacity of evaporator and their applications, Classification of chillers Construction and working of dry expansion Chillers, flooded chillers and their applications. **04 Marks**		
Topic 4. Psychrometry Specific Objectives: ➢ Define Psychrometric properties and draw processes Solve the problems with Psychrometric chart ➢ Understand Details of equipments used in air conditioning Contents: 4.1 Definition and necessity of air Conditioning, Properties of Air, Dalton's law of partial pressure, Psychrometric chart, Psychrometric processes, Bypass Factor, ADP, concept of SHF, RSHF, Adiabatic mixing of Air Streams, Simple numericals using Psychrometric Chart **08 Marks** 4.2 Air- conditioning Equipments: **08 Marks** • Humidifier dehumidifier, filters, • Heating and cooling coils. • Air washers	08	16
Topic 5. Comfort Conditions and Cooling Load Calculations Specific Objectives: ➢ Explain basic concepts of comfort conditions and cooling load calculations Contents: 5.1 Thermal exchange of body with environment, Factors affecting human comfort, Effective temp. 5.2 Components of cooling load- sensible heat gain and latent heat gain sources 5.3 Calculation of cooling load of given area.	04	08
Topic 6. Air Conditioning & Air Distribution Systems Specific Objectives: ➢ Identify various air conditioning systems Contents: 6.1 Classification of systems: **06 Marks** • Industrial and commercial Air Conditioning Systems • Summer, winter and year round Systems	08	16

• Central and unitary air conditioning systems 6.2 Air distribution systems **06 Marks** • Duct systems: Closed perimeter system, extended plenum system, Radial duct system, duct materials, requirement of duct materials, losses in ducts • Fans and Blowers- Types, working of fans and blowers , Air distribution outlets, Supply outlets, return outlets, grills, and types of diffusers 6.3 Insulation: Purpose, properties of insulating material, Types of insulating materials, Methods of applying insulation. **04 Marks**		
Topic 7. Applications of Refrigeration and Air Conditioning Systems: 08 Marks Specific Objectives: ➢ Explain various Refrigeration and Air Conditioning systems. Contents: Applications of refrigeration and air conditioning in following areas: • Domestic Applications • Commercial Applications • Industrial Applications • Automobile Air conditioning systems	04	08
Total	**48**	**100**

Practical:
Skills to be developed:

Intellectual Skills:

1. Identify various components of refrigeration and air conditioning equipment.
2. Analyse cooling load based on application.
3. Interpret psychometric chart to find various properties of air.

Motor Skills:

1. Handle various tools used for refrigeration and air conditioning plant Maintenance.
2. Dismantle and assemble Refrigeration compressor and components.
3. Use of temperature, pressure, energy measuring devices.
4. Draw the layout of central Air conditioning plant.
5. Conduct trial on Test rigs.

List of Practicals:

Instructions to Teachers: While conducting experiments, group of 4 – 5 students should be formed. For industrial visits group size be limited to 8 -10 students at a time.

1. Identification, Location of components on various refrigeration systems like House hold refrigerator, Window air conditioner, Split Air conditioner, Water Cooler, Deep freezer and controls used.(Concept of EER and star rating to be emphasized in relation with these equipments). Draw the block diagrams to show location of components and label them.

2. Demonstration of various Valves, controls like, solenoid valve, Thermostatic Expansion valve, capillary, L.P./H.P. cut outs, thermostats, overload protectors, Gauges used in RAC systems.
3. Trial on Vapor Compression cycle test rig to find COP.
4. Trial on Ice Plant test rig.
5. Visit to cold storage plant / Ice cream Manufacturing plant/ Ice plant and write a brief report.
6. Calculation of Relative Humidity in the area with help of Sling Psychrometer and Psychometric Chart
7. Trial on Air conditioning test rig.
8. Dismantling and assembling of hermatically sealed compressor **(To be performed by group of 4 -5 student)**
9. Dismantling and assembling of Reciprocating refrigeration compressor. **(Batch size of students should be 4-5 in a group)**
10. Dismantling and assembling of Car Air-conditioning compressor. **(Batch size of students should be 4-5 in a group)**
11. Visit to repair and maintenance workshop of Refrigeration & Air conditioning in view of use of various tools and charging procedure and write a brief report.

    OR

    Visit to central A.C. plant in view of ducting system, insulation system and Air Distribution system (e.g. frozen food industry / ice- cream industry/mushroom plants / textile industries).
12. Trouble shooting chart of domestic refrigerator, window air- Conditioner, Water cooler, Automobile air conditioning systems (any two)

    (It is recommended that the teacher should introduce manufacturers catalogues of RAC equipments to the students during practical periods)

Assignments:-

1. Detailed information search on "Green House Effect" and "Ozone layer depletion" and "Eco friendly Refrigerents"
2. Study of Air conditioning system of a Car or Bus by practically observing system in view of identification of components, circuits, Type of refrigerants , Capacity and various controls used in system. Write a brief report.
3. Cooling load calculations for cabin, classroom, laboratory, canteen and dairy Plant, milk storage, small freezers (minimum one).

Learning Resources:
1. Books:

Sr. No.	Title	Author	Edition	Publisher
01	Refrigeration and Air Conditioning	Arora	3rd Edition	Tata McGraw Hill
02	Refrigeration and Air Conditioning	R.S.Khurmi	Recent	S. Chand and Co.
03	Refrigeration and Air Conditioning	P. N. Ananthanarayanan	1st Edition	Tata McGraw Hill
04	Refrigeration and Air Conditioning	Manohar Prasad	2009	New Age Publications
05	Principles of Refrigeration	Roy Dossat	4TH	Pearson Education
06	Refrigeration and Air Conditioning	Ballany	2009	Dhanpat rai & sons

2. CDs, PPTs, Video Clips on refrigeration and air conditioning systems. Video clips on working of refrigeration and air conditioning systems, working of compressors, vapour absorption systems, alternative refrigerants.

3. ISO, IS, BS Codes on components of refrigeration and air conditioning systems. ASHRAE codes.

4. Charts, Models, Transparencies on Refrigeration and air conditioning.

5. Websites: Carrier corporation, Voltas, Usha, Fedders Loyd, Hitachi, Du-Pond, Tata Mac graw hill (student section) for refrigeration and air conditioning products.

Course Name : Mechanical Engineering Group

Course Code : ME/PG/PT/MH/MI

Semester : Sixth for ME/PG/PT and Seventh for MH/MI

Subject Title : Solid Modeling

Subject Code : 17063

Teaching and Examination Scheme

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
01	--	02	--	--	25#	--	25@	50

Rationale:

Technically 3 dimensions refers to objects that are constructed on 3 planes (X,Y,Z). The process of creating 3 dimensional (3D) computer graphics can be divided into 3 basic phases - 3D modeling, 3D animation & 3D rendering. 3D models means solid model is usually originated on the computer by engineer using some kind of solid modeling softwares. Solid modeling is a process of developing a mathematical representation of any 3 dimensional object. The solid model may be created using solid modeling softwares. Solid models are often animated for some uses.

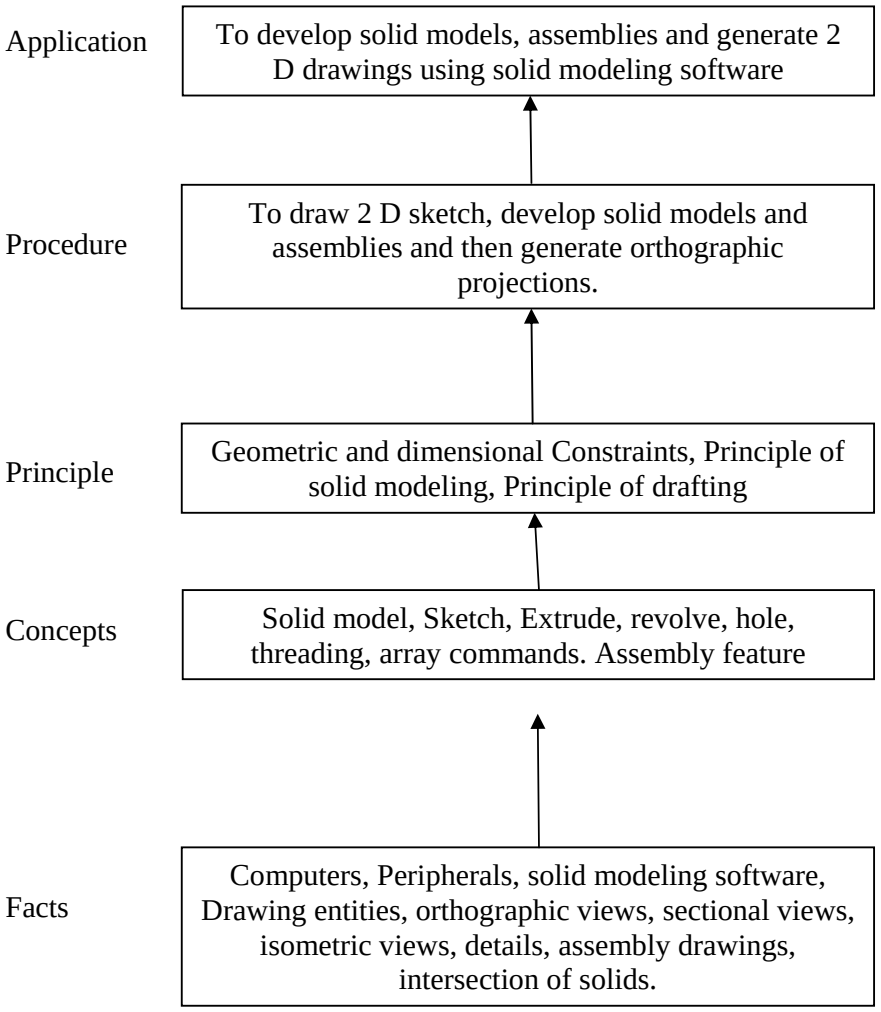
Today 3D models are used in wide variety of engineering fields. Three dimensional computer graphics are widely used for product design, assembly design etc. As a diploma engineer he should have the knowledge of solid modeling software to visualize the machine components & assembly like cars, machine tools and earth movers etc.

General Objectives:

Students will be able to

1) Use appropriate commands
2) Develop solid models from 2 D drawing.
3) Use of printers / plotters.

Learning Structure:



Theory:

Topic and Content	Hours
Topic 1: Introduction to Solid Modeling **Content:** Introduction, Applications, Benefits, Need, Hardware Requirements, Different Software packages used for Solid Modeling.	02
Topic 2: Working in 2 D environment **Content:** **2.1 Working in Sketcher mode** – Line, Profile, Circle, Arc, Rectangle and their sub options. **2.2 Constraints** - Dimensioning constraint, Geometrical constraint.	02
Topic 3: Creation of solid models **Content:** **3.1 Working in 3 D environment** -Creating 3D Solid Models of simple machine parts. **3.2 Intersection of solids** – Intersect 2 solid components by inserting new body option, Boolean operations – Union, subtract, intersection.	04
Topic 4: Assembly Drawing **Content:** **4.1 Assembly Drawing** - Preparation of Assembly drawing by using assembly features. (Assembly of minimum 4-5 components) **4.2 Exploded view** – Explode the assembly.	04
Topic 5: Working in Drafting Mode **Content:** **5.1 Orthographic projections** – Generate orthographic projections which will include all types of views – front view, top view, side view, sectional views, isometric views, auxiliary views. **5.2 Dimensioning Commands** – Apply dimensions, dimensional and geometrical tolerances. **5.3 Bill of material** – Prepare part list table and name plate	03
Topic 6: Plotting drawing **Content:** Page set up, Plot command.	01
Total	**16**

Note: Multimedia projection facility shall be used during lecture sessions along with computer facility e.g. laptop, computer, LCD projector.

Practical:
Skills to be developed

Intellectual skills:

1) Interpret a drawing to draw in solid Modeling software.
2) Use command dialogue box.

Motor Skills:

1) Use toolbars.
2) Use printers or plotters.

Guideline for Practical:

1) One student per computer terminal.
2) For assembly drawing practical work select any one assembly like oldham's coupling, cotter Joint, knucle Joint, stop valve, piston and cylinder assembly, lathe tool post, bearing block assembly, screw jack, tail stock etc.

List of Practicals:

1. Creation of minimum 4 different 2 D sketches
2. Creation of at least 5 solid models using solid modeling features.
3. Creation of 2 assembly drawings each of at least 5 components.
4. Generation of orthographic projections front view, top view, side view, isometric view.
5. Generation of sectional view.
6. Generation of auxiliary view.
7. Intersection of solids (at least 2 assignments)
8. Plotting of above drawings on A2/A3 size sheet.

Note: Use of any one Solid Modeling Software of Latest Version is recommended.

Practical Examination: (2 Hours for each student)
Creation of 3D Model and their 2 D views from the given part drawing followed by oral examination based on above term work. (One candidate on one computer terminal.)

Course Name : Mechanical Engineering Group

Course Code : AE/ME/MH/PT/PG/FG/FE

Semester : Sixth for AE/ME/PG/PT/FG and Seventh for MH/MI/FE

Subject Title : Project

Subject Code : 17090

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
--	--	04	--	--	--	50#	50@	100

Rationale:

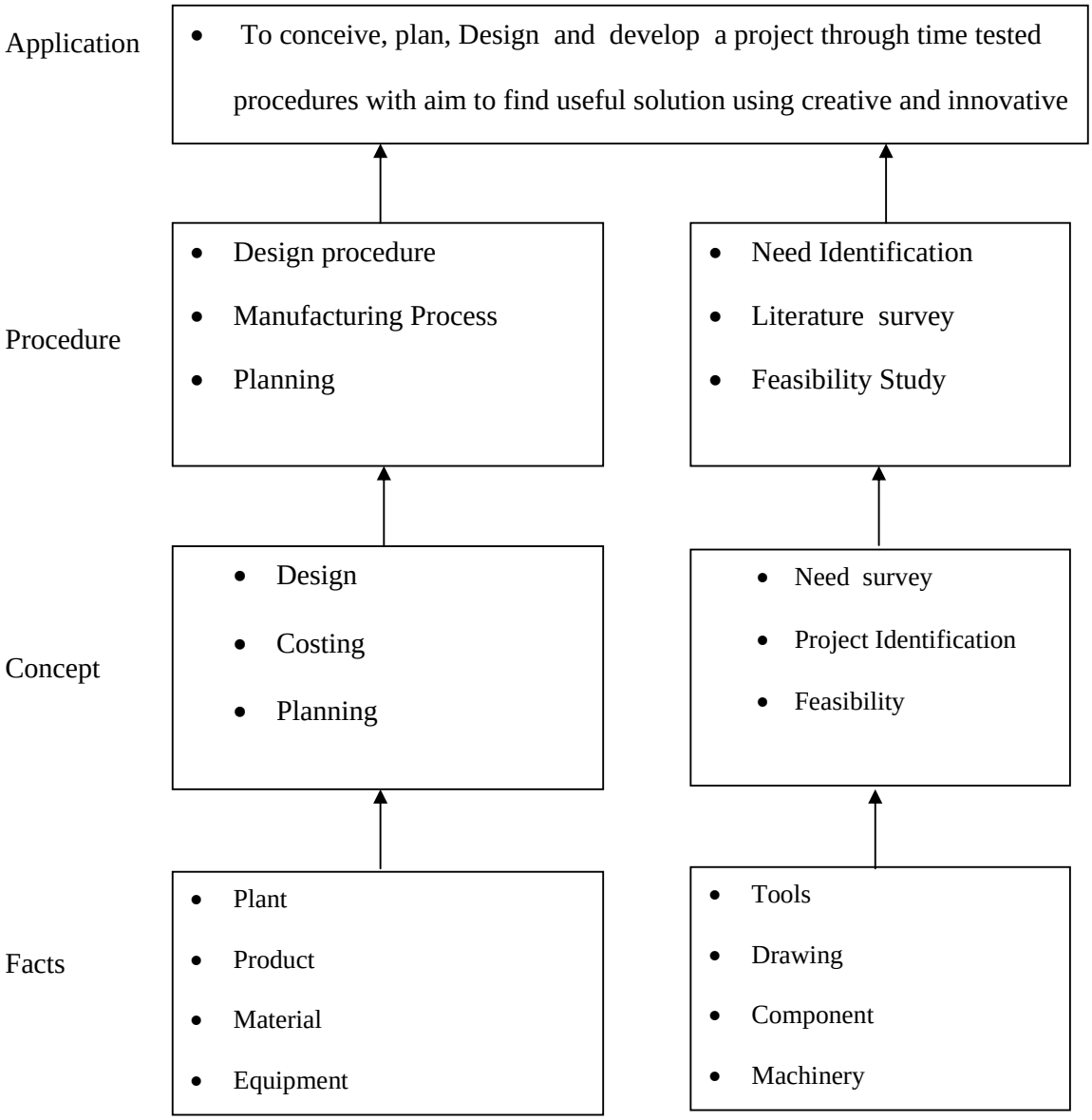
Project work allows students to use their creative and innovative ideas translating in working model, prototypes, and equipments and developing necessary hands on skills. This will allow the students to apply the previous knowledge and skills acquired during the course.

General Objectives:

The student will be able to:

1. Analyze the given problem.
2. Generate alternative solutions to the problem.
3. Compare & select feasible solutions amongst alternative generated.
4. Develop and manufacture new/modified equipments.
5. Acquire technical knowledge beyond curriculum.

Learning Structure:



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Content:

Following activities related to project are required to be dealt with, during this semester

1. The Selection and preliminary work regarding Project to be done as per directives given in **PROFESSIONAL PRACTICES – V** Curriculum.
2. The identified projects be executed during the semester as per the Guidance from the project Guide by the group of students (Group size max. 4 students).
3. Maintain the project diary individually for the activities performed in the format specified below.

Project Diary format:

Sr. No.	Date	Activity Carried out	Remarks	Signature of Guide

SUGGESTED PROJECT WORK AREAS

1) Fabrication of small machine / devices/ test rigs/ material handling devices/ jig & fixtures/ demonstration models, etc.
2) Design & fabrication of mechanisms, machines, Devices, etc.
3) Development of computer program for designing and /or drawing of machine components, Simulation of movement & operation, 3D modeling, pick & place robots
4) Industry sponsored projects- project related with solving the problems identified by Industry should be selected. (One person from industry is expected to work as co- guide along with guide from institution).
5) Literature survey based projects: Project related with collection, tabulation, classification, analysis & presentation of the information. Topic selected must be related with latest technological developments in mechanical field, and preferably beyond curriculum.
6) Modification in the existing machinery / equipment for improved performance.
7) Maintenance based projects.
8) Industrial engineering based project: Project based on work study, method study, methods improvement, leading to productivity improvement.
9) Low cost automation projects.
10) Innovative/ Creative projects involving generation of new ideas and converting it into a model, gadget.
11) Market survey based projects.
12) Project based on use of appropriate technology particularly benefiting rural society or economically weaker section.
13) Equivalent level project can be selected from other than the area specified above.

Note:

Project should provide viable and feasible solution to the problem identified.
Report should be of 40TO 50 pages.
Font size of project report contents be as follows:

1. Main title: 16 bold Times new roman
2. Sub titles: 14 bold Times new roman
3. Running matter: 12 Times new roman, paragraph 1.5 line spacing,
4. Margin spacing 1.5 inch from left and 1 inch from other sides.

Preferably actual photographs / video clips showing progress of project work at different stages be added to project report).
Suggested framework for the project report:

The topics/ contents of the project report should be as follows:-

- Abstract
- Topic introduction/ Philosophy
- Literature Survey/ Methodology adopted
- Principle (aim objectives of the Project work)
- Data collection/ Design consideration/Basic Framework/Design / Drawing
- Manufacturing Processes and Process Sheets (if relevant)
- Assembly (if relevant)
- Performance / Calculations etc (If relevant)
- Costing
- Results and Discussion
- Conclusion
- Future Scope
- Bibliography/ References

Learning Resources:
Reference Books:

Sr. No.	Name of Book	Author	Publisher
1	Project Management	Maylor	Pearson Education
2	Project Management And Appraisal	Khatua	Oxford University Press
3	Project Management/2/e	Bhavesh Patel	Vikas Publishing House
4	Project Management 3/e	Vasant Desai	Himalaya Publishing House
5	Project Management The Managerial Approach	Gray	TMH

Course Name : Mechanical Engineering Group

Course Code : AE/ME/PG/PT/MH/MI/FG/FE

Semester : Sixth for AE/ME/PG/PT/FG and Seventh for MH/MI/FE

Subject Title : Entrepreneurship Development

Subject Code : 17099

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
01	01	--	--	--	--	--	25@	25

Rational:

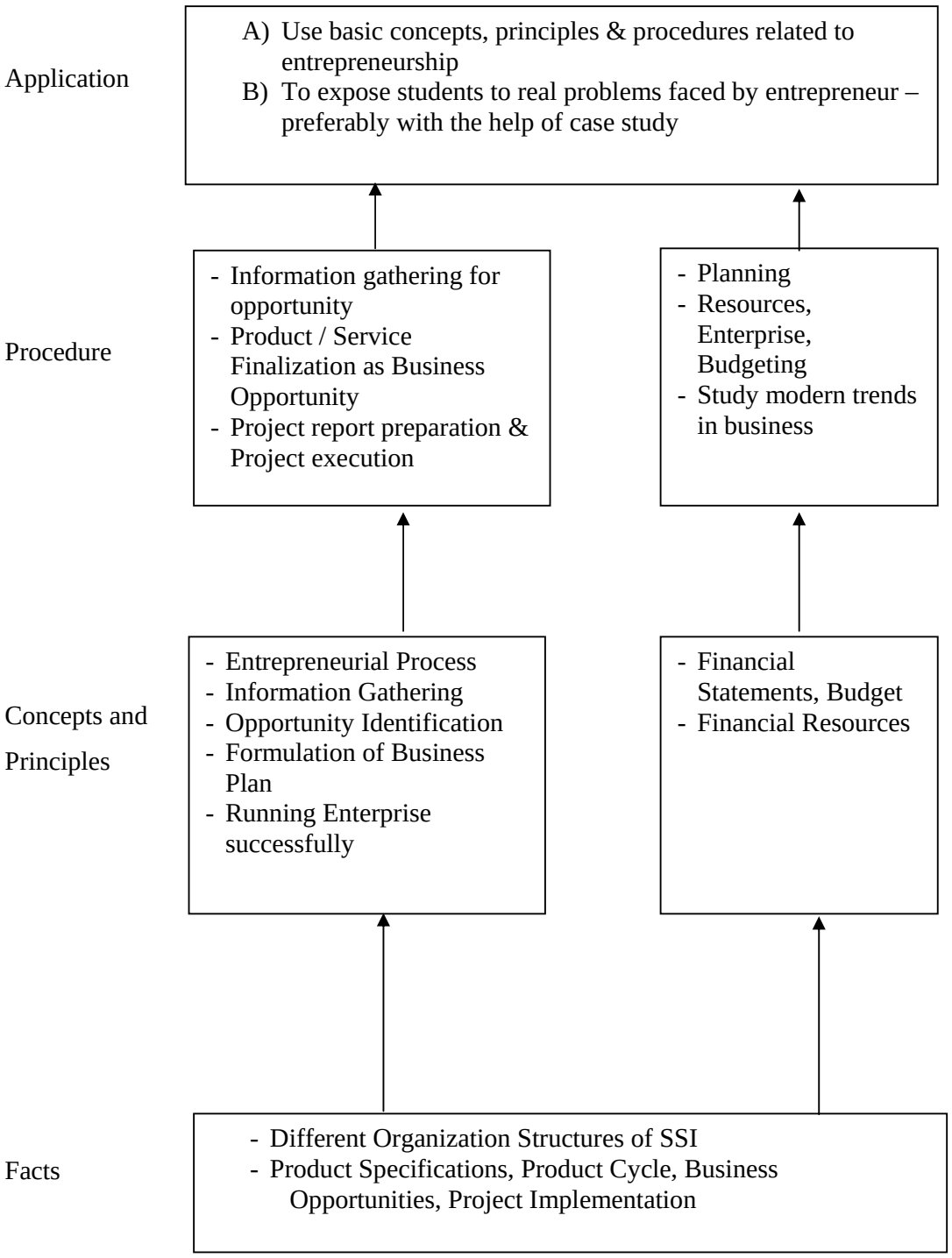
Globalization, liberalization & privatization along with revolution in Information Technology, have thrown up new opportunities that are transforming lives of the masses. Talented and enterprising personalities are exploring such opportunities & translating opportunities into business ventures such as- BPO, Contract Manufacturing, Trading, Service sectors etc. The student community also needs to explore the emerging opportunities. It is therefore necessary to inculcate the entrepreneurial values during their educational tenure. This will help the younger generation in changing their attitude and take the challenging growth oriented tasks instead of waiting for white-collar jobs. This subject will help in developing the awareness and interest in entrepreneurship and create employment for others.

General Objectives:

The students will be able to

1) Appreciate the concept of Entrepreneurship
2) Identify entrepreneurship opportunity.
3) Develop entrepreneurial values and attitude.
4) Collect and use the information to prepare project report for business venture.
5) Develop awareness about enterprise management.

Learning Structure:



Content:

Topic and Contents	Hours
1. Entrepreneurship, Creativity & Opportunities **Specific objectives:** ➢ Know the characteristics of entrepreneur and business **Contents:** 1.1 Concept, Classification & Characteristics of Entrepreneur 1.2 Creativity and Risk taking. 1.3 Business types and Reforms 1.4 SWOT Analysis	03
2. Information and Support Systems for Development of Entrepreneurship **Specific objectives:** ➢ Know the various information sources and support systems **Contents:** 2.1 **Information Sources:** Information related to project, procedures and formalities 2.2 **Support Systems** 1) Business Planning & Requirements for setting up an SSI 2) Govt. & Institutional Agencies (Like MSFC, DIC, MSME, MCED, MSSIDC, MIDC, LEAD BANKS) Statutory Requirements and Agencies.	03
3. Market Assessment and feasibility **Specific objectives:** ➢ Know the market requirement and customer needs through survey and feasibility analysis **Contents:** 3.1 Marketing -Concept and Importance, Market Identification. 3.2 Customer need assessment, Market Survey, Product feasibility analysis	02
4. Business Finance & Accounts **Specific objectives:** ➢ Know the basics of elements of costing, financial resources and business accounting procedure **Contents:** 4.1 **Business Finance:** Costing basics, Sources of Finance, Break Even Analysis. 4.2 **Business Accounts:** Book Keeping**,** Financial Statements, Financial Ratios and its importance, Concept of Audit.	03
5. Project Report Preparation **Specific objectives:** ➢ Understand and plan the steps in starting the business ➢ Prepare project report and carry out project feasibility study **Contents:** 5.1 Business plan: Steps involved from concept to commissioning 5.2 **Project Report** 1) Meaning and Importance 2) Components of project report/profile 5.3 **Project Feasibility Study:** 1) Meaning and definition 2) Technical, Market, Financial feasibility	03
6. Enterprise Management And Modern Trends **Specific objectives:** ➢ Know the role of entrepreneur in management of enterprise ➢ Understand the concept of E-Commerce **Contents:**	02

6.1 **Enterprise Management** 1) Essential roles of Entrepreneur in managing enterprise 2) Probable causes of sickness 6.2 E-Commerce: Concept and process 6.3 Global Entrepreneur	
Total	**16**

Tutorial:

Sr. No	Assignments
1	Assess yourself-are you an entrepreneur?
2	An Interview with an Entrepreneur.
3	Feasibility study of a product.
4	Prepare a Project Report for starting a small scale business.

Note - A teacher shall guide the students during tutorial periods for writing the above assignments**.**

Learning Resources:
1) Reference Books:

Sr. No.	Name of Book	Author	Publisher
1	Entrepreneurship	Trehan	Dream Tech Press
2	Entrepreneurship 2/e	Rajeev Roy	Oxford University Press
3	Entrepreneurship and Small Business	Schaper	Wiley India Publication
4	Entrepreneurship Development	Colombo plan staff college for Technical education.	Tata McGraw Hill Publishing co. ltd. New Delhi.
5	Poornima M. Charantimath	Entrepreneurship Development of Small Business Enterprises	Pearson Education
6	Entrepreneurship Development	E. Gorden K.Natrajan	Himalaya Publishing. Mumbai

2) Video Cassettes:

Sr. No.	SUBJECT	SOURCE
1	Five success Stories of First Generation Entrepreneurs	EDI STUDY MATERIAL Ahmedabad (Near Village Bhat , Via Ahmadabad Airport & Indira Bridge), P.O. Bhat 382428 , Gujrat,India P.H. (079) 3969163, 3969153 E-mail: ediindia@sancharnet.in/olpe@ediindia.org Website : http://www.ediindia.org
2	Assessing Entrepreneurial Competencies	
3	Business Opportunity Selection and Guidance	
4	Planning for completion & Growth	
5	Problem solving-An Entrepreneur Skill	