MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION (MSBTE)

I – Scheme
II – Semester Course Curriculum

Course Title: **Basics of Mechanical Engineering**
(Course Code: .....)

Diploma programme in which this course is offered	Semester in which offered
Electrical Engineering	Second

1. RATIONALE

The electrical engineering technologists have to often use some of the basic aspects of mechanical engineering when handling different types of electrical machines such as bearings, shafts, couplings and such others. Therefore, it is essential that the electrical engineering technologists are to perform simple mechanical engineering tasks for which the basics of mechanical engineering need to be learnt. This requires the basic understanding of the of force, work, energy, materials used for making the machines, principles of motion, their transformation, and the methods of maintenance. equipment and machines, like transmission systems and others for their day-to-day working of the machines. Hence, this course has been developed to address such needs.

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 basic principles of mechanical engineering when using electrical machines.**

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 force, work, and energy in the area of electrical engineering.
b. Use principles of kinetics and kinematics for in the area of electrical engineering.
c. Identify different mechanisms in electrical machines.
d. Estimate the values of mechanical properties of materials.
e. Use relevant lubricants in electrical machines.
f. Select relevant mechanical transmission drives for electrical machines.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	-	2	6	80	20*	25	25	150

(*): *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, Learning Outcomes i.e. LOs 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.

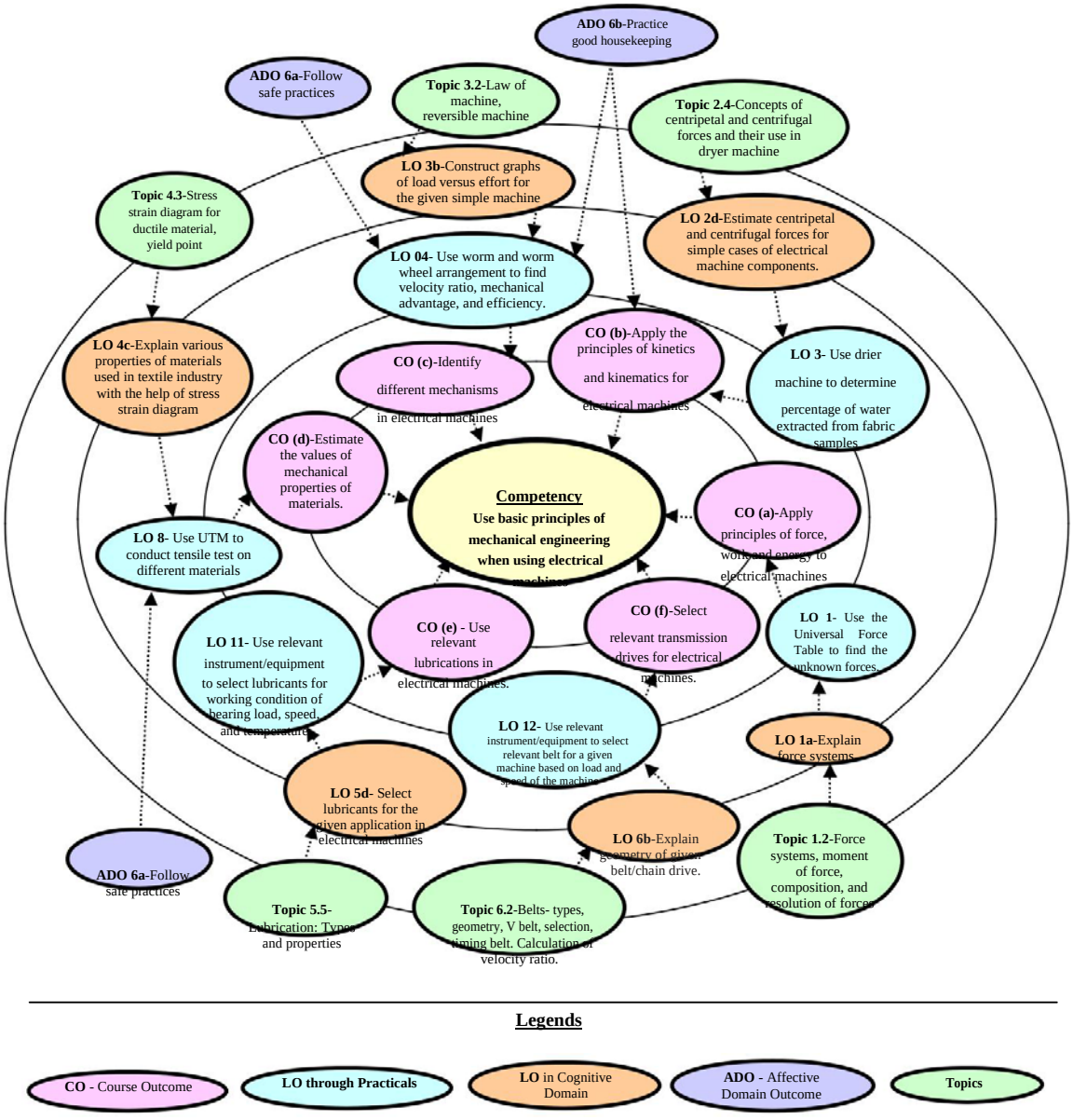

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals/exercises/tutorials in this section are psychomotor domain LOs (i.e. sub-components of the COs) are to be developed and assessed in the student to lead to the attainment of the competency.

S. No.	Practical Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
1	Use the Universal Force Table to find the unknown forces.	I	02*

S. No.	Practical Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
2	Use Five Steel plates of unknown weight to determine the weight of a given plate by equilibrium of co-planner, non-concurrent, non-parallel forces.	I	02
3	Use drier machine to determine percentage of water extracted from fabric samples.	II	03*
4	Use worm and worm wheel arrangement to find velocity ratio, mechanical advantage, and efficiency.	III	02*
5	Use table mounted single purchase crab and double purchase crab to find velocity ratio, mechanical advantage, and efficiency.	III	03
6	Use '2D-working model software'/similar software and related mechanism to calculate displacement, velocities and acceleration of different links.	III	04
7	Use relevant arrangement to determine strain and stress in the given spring.	IV	02*
8	Use UTM to conduct tensile test on different materials to determine the ultimate strength, yield strength, percentage elongation, and percentage reduction in area.	IV	04
9	Identify isotropic material, homogeneous material from given set of materials.	IV	02
10	Determine coefficient of friction between different surfaces like metal, wood, glass.	V	02*
11	Use relevant instrument/equipment to select lubricants for working condition of bearing load, speed, and temperature.	V	02
12	Use relevant instrument/equipment to select relevant belt for a given machine based on load and speed of the machine.	VI	02*
13	Use relevant instrument/equipment to select relevant chain for a given machine based on load and speed of the machine	VI	02
	Total		**32**

Note

i. 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.*

ii. Hence, the 'Process' and 'Product' related skills associated with each LO of the laboratory/workshop/field work are 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**

Additionally, the following affective domain LOs (social skills/attitudes), are also important constituents of the competency which can be best developed through the above mentioned 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 development of the attitude related LOs of Krathwohl's 'Affective Domain Taxonomy', the achievement level may reach:

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Universal Force Table (Consists of a circular 40 cm dia. Aluminum disc, graduated into 360 degrees.) with all accessories.	1, 2
2	Five Steel plates of unknown weight.	1, 2
3	Weights 50gm, 100gm, 200gm, 500gm, 1000gm (three pieces of each).	1, 2, 4,5,7
4	Differential axle and wheel (wall mounted unit with the wheel of 40 cm diameter and axles are insteps of 20 cm and 10 cm reducing diameter .	4, 5,
5	Worm and worm wheel (wall mounted unit with threaded spindle, load drum, effort wheel; With necessary slotted weights, hanger and thread).	4
6	Simple screw Jack (Table mounted metallic body , screw with a pitch of 5 mm carrying a double flanged turn table of 20 cm diameter.	4, 5
7	Single Purchase Crab winch (Table mounted heavy cast iron body. The effort wheel is of C.I. material of 25 cm diameter mounted on a shaft of about 40mm dia. On the same shaft a geared wheel of 15 cm diameter.	5
8	Double Purchase Crab winch (Having assembly same as above but with double set of gearing arrangement)	5
9	Wooden or Acrylic working models of various popular mechanisms	4, 5, 6
10	Latest licensed networking version of '2D-working model software'/similar planar mechanism simulation software.	4, 5, 6
11	1 meter and half meter steel rules.	1 to 9
12	Helical springs (Close and open coil) of different sizes and stand.	7, 8, 9
13	Universal Testing Machine 5 Ton capacity.	7, 8, 9
14	Friction apparatus for motion along horizontal and inclined plane (base to which a sector with graduated arc and vertical scale is provided. The plane may be clamped at any angle up to 45 degrees pan. Two weight boxes (each of 5 gm. 10 gm. 2-20 gm. 2-50 gm. 2-100 gm. weight).	10, 11
15	Mass hanger and pointer for friction apparatus.	7, 8, 9
16	Glass strip, Wooden surface, Metallic surface for friction apparatus.	10, 11

S. No.	Equipment Name with Broad Specifications	Exp. No.
17	Working model of different drives such as gear drive, belt drive.	12, 13
18	Actual belts, chains, gears and bearings commonly used in textile industries.	12, 13

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Force, Work and Energy	1a. Explain the given terms. 1b. Construct polygon of forces with the given data. 1c. Apply principles of work in the given electrical machine. 1d. Identify the application of potential energy in the given electrical machine.	1.1 Force, principle of transmissibility of force 1.2 Force systems, moment of force, composition and resolution of forces 1.3 Equilibrium and resultant of forces 1.4 Work- definition, work of force, work of couple moment 1.5 Energy- potential energy, gravitational potential energy, elastic potential energy, kinetic energy
Unit– II Kinetics and Kinematics	2a. Evaluate weight of the given substance related to the given electrical machine from its mass. 2b. Explain the given type of motion. 2c. Calculate linear and angular velocities and accelerations for the given simple case of electrical machine component. 2d. Estimate centripetal and centrifugal forces for the given simple case of electrical machine component.	2.1. Kinetics – Mass, weight, inertia, momentum, impulse. 2.2. Newton's laws of motion. 2.3. Kinematics – linear and angular motion. 2.4. Concepts of centripetal and centrifugal forces and electric machine.
Unit– III Machines and Mechanisms	3a. Determine efficiency of the given simple machine. 3b. Construct graphs of load versus effort for the given simple machine. 3c. Suggest simple mechanisms for the given situation. 3d. Calculate velocity and acceleration of the given simple mechanism.	3.1 Machines - definition, mechanical advantage, velocity ratio, efficiency, simple numerical. 3.2 Law of machine, reversible machine, simple numerical. 3.3 Simple machines: wheel and axle, simple screw jack, worm, and worm wheel, single and double purchase crab. 3.4 Planar Mechanisms- slider crank mechanism and four bar chain mechanism.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		3.5 Inversions of mechanism. 3.6 Use of simulation software.
Unit-IV Mechanical properties of materials.	4a. Identify stresses in the given component of the given electrical machine. 4b. Estimate stresses in the given component of given electrical machine under simple loading. 4c. Explain various properties of the given material using stress strain diagram. 4d. Calculate factor of safety in the given situation for the given data.	4.1 Simple stresses and strains – stress, strain, types of stresses, simple numerical. 4.2 Hooke's law, elastic limit, Modulus of elasticity, modulus of rigidity, ultimate stress, working stress, simple numerical. 4.3 Stress strain diagram for ductile material, yield point. 4.4 Factor of safety. 4.5 Material: Isotropic, homogeneous, and orthotropic material, their applications.
Unit –V Friction and lubrication.	5a. Evaluate coefficient of friction of the given sample. 5b. Suggest the type of bearing to be used in the given situation with justification. 5c. Select bearings for the given application in electrical industry with justification. 5d. Select lubricants for the given application in electrical industry with justification.	5.1 Concept of friction, laws of friction, types of friction, factors affecting friction, coefficient of friction 5.2 Types of bearings: journal bearing, ball bearing and roller bearing, uses of bearings in textile industry 5.3 Bearing specifications and code system and description. 5.4 Selection of bearings, criteria of selection 5.5 Lubrication: Types and properties
Unit-VI Transmission	6a. Select the relevant mechanical drive for the given application with justification. 6b. Explain geometry of the given type of belt/ chain drive to be used with the given type of electric motor. 6c. Explain the terminologies related to the given type of gear with sketches. 6d. Compare the construction the given two types of gear trains. 6e. Calculate the velocity ratio for the given condition.	6.1 Mechanical drives- Types. 6.2 Belts: Types, geometry, V-belt, selection, timing belt, calculation of velocity ratio. 6.3 Chains: Types, geometry, roller chain sprocket, velocity ratio. 6.4 Cams: Types of cams, types of followers, follower positions, follower shape and motion 6.5 Gears: Types and applications 6.6 Spur gear terminologies, involute tooth profile 6.7 Gear in mesh: Interference, undercutting, backlash, calculation of velocity ratio 6.8 Gear trains: simple, compound, reverted and epicyclic.

***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'.*

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	Force ,Work and Energy	08	02	02	03	07
II	Kinetics and Kinematics	08	01	03	04	08
III	Machines and Mechanisms	08	02	04	05	11
IV	Mechanical properties of materials	13	03	05	05	13
V	Friction and lubrication	13	03	04	08	15
VI	Transmission	14	03	05	08	16
Total		**64**	**14**	**23**	**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 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. Undertake survey of lubricants used in electric machines.
b. Give seminar on any relevant topic.
c. Library survey regarding engineering material used for transformers.
d. Prepare power point presentation or animation for showing different types of transmission drives used in electrical machines.
e. Undertake a survey of different types of electric machines and mechanisms used in process industry.

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.
f. Demonstrate estimation of kinematic data of various mechanisms used in typical assembly line industry through 2D working model/similar software.
g. Use of video, animation films to explain concepts, facts and applications related to construction and working of different transmission drives.

h. Use real components to teach the concepts related to belts, chains, bearings, gears, V-pulley, timers, pulleys and others
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 practicals, cognitive domain and affective domain LOs. 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 undertaken individually 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. The concerned faculty could add similar micro-projects:

a. **Energy:** Compile the applications of centrifugal and centripetal forces in various electric machines.
b. **Mass and Weight:** Determine the mass and weight of different materials used in a 1 MVA distribution transformer.
c. **Machines:** Prepare graphs of load versus effort to demonstrate efficiency of various types of motors.
d. **Mechanisms:** Prepare models for combination of different linkages to form different mechanisms.
e. **Materials**: Prepare chart of different materials used in 2 MVA high voltage transformer
f. **Bearings**: Collect bearings according to the specifications and their uses in different types of electric machines.
g. **Lubricants**: Prepare charts indicating lubricant, specification and their use in electric machines.
h. **Belts**: Select relevant belt for different process industries using large electrical motors.
i. **Gears:** Prepare chart displaying specifications of different gears and gearboxes used along with electrical machines.
j. **Gear trains:** Prepare model of gear train useful for electrical machines.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Machine and Mechanisms	Myszka, David H.	Pearson Education, New York, 2011, ISBN: 9780132157803
2.	Theory of Machines and Mechanisms.	Shigley, Joseph, E, Uicker, J. J. Jr., Pennock, G. R.	Oxford University Press, New York, 2011, ISBN: 9780195371239
3.	Theory of Machines and Mechanisms.	Rattan, S.S.	Tata McGraw-Hill Education, New Delhi, 2009, ISBN: 9780070144774

S. No.	Title of Book	Author	Publication
4.	Basic Electrical Engg.	Mittle, V. N.	Tata McGraw-Hill, New Delhi ISBN : 978-0-07-0088572-5
5.	Electrical Technology	Hughes, Edward	Pearson Education, New Delhi ISBN-13: 978-0582405196
6.	Strength of Materials, Vol. I: Elementary Theory and Problems	Timoshenko, S. P.	CBS Publishers, New Delhi, 2004, ISBN: 9788123910307
7.	Strength of Materials Vol. II: Advanced Theory and Problems: 2	Timoshenko, S. P.	CBS Publishers, New Delhi, 2002, ISBN: 978812 3910772
8.	Engineering Mechanics	Bhavikatti, S. S., Rajashekarappa, K. G.	New Age International, New Delhi, 1994, ISBN:9788122406177
9.	Engineering Mechanics Statics and dynamics	Shames, I. H.	Pearson Education India, New Delhi 2005, ISBN:9788177581232

14. SOFTWARE/LEARNING WEBSITES

a. www.physicsclassroom.com/mmedia/kinema
b. fearofphysics.com/Friction/frintro.html
c. www.sciencejoywagon.com/physicszone
d. www.science.howstuffworks.com
e. phet.colorado.edu/en/simulation/forces-and-motion-basics
f. phet.colorado.edu/en/simulation/friction
g. www.nptel.ac.in/courses/112102015/22
h. hperphysics.phy-astr.gsu.edu/hbase/hph.html
i. www.mechanicalhero.com/2011/12/mechanical-drives.html
j. physics.stackexchange.com/questions/27897/difference-b-w-kinetics-kinematics-w-concrete-example
k. www.mecheng.iisc.ernet.in/~bobji/funtri/assign/Lubricants.htm
l. onlinelibrary.wiley.com/subject/code/000080
m. nptel.ac.in/courses/116102012/