

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester – I & II

Course Title: **Basics of Mechanical Engineering**

(Course Code: 4300017)

Diploma Programme in which this course is offered	Semester in which offered
Electrical	First
Civil, Environment, Mining, Metallurgy, Plastics	Second

1. RATIONALE

Now a days as an advancement of technology interdisciplinary knowledge is must for the engineering diploma holders. An engineering diploma holder expected to look after many activities at work place, which may be of interdisciplinary. Knowledge other than own discipline plays important role in the development of individual as well as society. This course mainly encompasses the major areas of mechanical engineering which are being used by engineering diploma holders and are required to perform tasks such as selection of hand tools, power tools, welding, cutting, manufacturing processes, diesel generator sets, refrigeration and air conditioning, hydro-pneumatic devices/equipment, and material handling equipment used for various purposes. Such skills can be developed by knowing the basic principles of mechanical engineering. The motive of this subject is to enhance the knowledge & skill level in the interdisciplinary area. This course is designed in such a way that practical performed in this course will develop these basic skills to perform well in industry as well as in field work.

2. COMPETENCY

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

- **Apply basic principles of mechanical engineering in various engineering applications.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

- a) Use relevant mechanical power and hand tools in real life applications.
- b) Select relevant power transmission mode in simple engineering situation.
- c) Use relevant manufacturing process for various components.
- d) Identify different components of various thermal systems.
- e) Identify various hydro-pneumatic devices/equipment.
- f) Use material handling equipment for given situations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	2	2	3	-	-	25*	25	50

(*): Out of 25 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 15 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, *CA* - Continuous Assessment; *ESE* - End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. Some of the **PrOs** marked “*” are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Use different hand, power tools and pipe fitting tools for the given application	I	02*
2	Make simple pipe layouts using pipes and pipe fittings as per given drawing.	I	02
3	Assemble/dismantle given power transmission setup.	II	02*
4	Fix different transmission elements between two parallel shaft systems (Bike, Cycle, Washing Machine, etc.)	II	02
5	Assemble/dismantle different brakes, clutches and couplings.	II	02*
6	Produce a plain or taper turning job as per given drawing.	III	02
7	Prepare a job using arc and gas welding operation.	III	02
8	Perform soldering/brazing operation on the given job.	III	02*
9	Prepare a wooden joint as per the given drawing	III	02
10	Prepare a simple sheet metal product such as (Funnel or Box)	III	02*
11	Attach/detach different mountings and accessories on steam boiler model.	IV	02*
12	Assemble/dismantle impulse turbine model.	IV	02
13	Assemble/dismantle reaction turbine model.	IV	02
14	Assemble/dismantle two stroke and four stroke petrol engine (Any one).	IV	02*
15	Assemble/dismantle two stroke and four stroke diesel engine (Any one).	IV	02
16	Determine properties of air (Dry bulb temperature, Wet bulb temperature, Humidity).	IV	02
17	Assemble/dismantle centrifugal and reciprocating pump. (Any one)	V	02*
18	Assemble/dismantle water turbines models.	V	02
19	Assemble/dismantle centrifugal, reciprocating and screw	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	compressor model.(Any one)		
20	Design and assemble a pneumatic circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given training kit.	V	02
21	Design and assemble a hydraulic circuit that extends and retracts a single acting (spring return) and double acting cylinder on a given training kit.	V	02*
22	Identify different material handling equipment.	VI	02
	Minimum 14 Practical Exercises #		28Hrs

Note

- (#)Minimum 14 (fourteen) practical have to be performed which is equal to 28 hours and it should be a proper mix of practical which cover all the units.
- More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list of practical.
- The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Preparation of experimental set up.	20
2	Observation and recording.	20
3	Interpretation of result and conclusion.	20
4	Answer to sample questions.	10
5	Safety measures and good housekeeping.	10
6	Submission of report in time and attendance.	20
	Total	100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical's in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Plumbing tools- Coupling, Elbow, Bends, Tee, Plug, Cap, Nipple, Union, Reducer, Cross, Flanges.	For Demo in Tutorial class for Unit-I
2	Hand tools- Different spanners (Wrench), Pliers, Screw drives, Chisel, Hand hacksaw, Hammers.	1
3	Power tools- Portable Drilling and grinding machine, Electric power saw, portable electric cutter, electric demolition hammer, power screw driver.	1

S. No.	Equipment Name with Broad Specifications	PrO. No.
4	Plastic Pipes and Metal pipes of different diameters and connectors, different types of pipe fittings, different types of pipe joints.	2
5	Pipe wrench, pipe vice, hacksaw , plumb bob, dies, pipe cutter, files and rasps	2
6	Working models of different belts in different arrangement.	3, 4
7	Working models of belt drives, chain and sprocket, various gear drives.	3, 4
8	Working and cut section models of various types of brake assemblies.	3, 4, 5
9	Models (Wooden/Plastic/Metallic) of various clutch (suitable for dismantling)	5
10	Models (Wooden/Plastic/Metallic) of various coupling.(suitable for dismantling)	5
11	Center lathe machine(length between centers:1200mm)	6
12	Arc Welding machine welding current 20-400A.	7
13	Arc welding tools-electrode holder, cable connector, cable lugs, earthing clamp, wire brush.	7
14	Oxygen and acetylene gas welding and cutting kit with cylinders and regulators.	7
15	Gas welding tools- welding torch, welding tip, spark lighters.	7
16	Brazing and soldering kit. (Brazing kit with suitable silver and copper brazing alloy rods for ¼ " to 7/8" tubes- cu to cu, cu to steel, cu to brass and appropriate flux.)	8
17	Wood working tools- carpentry vice 150mm, marking and measuring tools, saws, claw hammer, mallet, chisel, squares.	9
18	Sheet metal material - Black iron, Galvanized iron, Stainless steel , Copper, Aluminum, Tin plate	10
19	Hand tools for sheet metal work - Trammers, Wire Gauge, Snips, Hammers, Stakes, Steel Metal Joints.	10
20	Models/cut section (Wooden/Plastic/Metallic) of fire and water tube boilers.	11
21	Models (Wooden/Plastic/Metallic) of different mountings and accessories for boilers.	11
22	Models/cut section (Wooden/Plastic/Metallic) of impulse and reaction turbine (suitable for dismantling)	12, 13
23	Model/cut section (Wooden/Plastic/Metallic) of two stroke and four stroke petrol engine (suitable for dismantling)	14
24	Model/cut section (Wooden/Plastic/Metallic) of two stroke and four stroke diesel engine (suitable for dismantling)	15
25	Sling psychomotor and thermometer.(Digital temperature and humidity measurement, temperature range of -25° C to 60° C or higher)	16

S. No.	Equipment Name with Broad Specifications	PrO. No.
26	Centrifugal pump (suitable for dismantling)	17
27	Reciprocating pump. (suitable for dismantling)	17
28	Model/cut section (Wooden/Plastic/Metallic) Pelton wheel, Francis and Kaplan turbine. (suitable for dismantling)	18
29	Centrifugal compressor (suitable for dismantling)	19
30	Reciprocating compressor (suitable for dismantling)	19
31	Screw compressor (suitable for dismantling)	19
32	Hydraulic and Pneumatic trainer	20, 21
33	Working models of material handling equipment	22

7. AFFECTIVE DOMAIN OUTCOMES

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

- Work as a leader/a team member.
- Maintain tools and equipment.
- Follow safety Practices.
- Practice good housekeeping.
- Follow ethical practices.
- Practice energy conservation.

The ADOs are best developed through the laboratory/field based exercises. 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
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Basic Mechanical Tools and Components	1a. Describe the significance of mechanical engineering in daily routine. 1b. Describe the procedure to Identify mechanical tools in general use. 1c. Select pipe and pipe fitting tools.	1.1. Introduction of mechanical engineering. 1.2. Use of mechanical engineering a. In day to day life. b. Interdisciplinary use 1.3. Items in general use- identification criteria, major types, specifications and uses:

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	1d. Use of different hand and power tools. 1e. Describe the significance of Industry 4.0 in 21 st century	such as bolts, nuts, washers, bearings, valves, bushes, springs, levers, rivets, keys, o' rings, oil seals, shafts, axles. 1.4. Pipes and pipe fittings- Types, specifications and uses. 1.5. Hand and power tools <ul style="list-style-type: none"> a. Types, specifications and uses of spanners (such as fix, ring, box, pipe, Allen, adjustable). b. Types, specifications and uses of hand tools (such as, Pliers, Screw drives, Chisel, Hand hacksaw, Hammers). c. Types, specifications and uses of power tools (Portable Drilling and grinding machine, Electric power saw, portable electric cutter, electric demolition hammer, power screw driver) 1.6. Industry 4.0, Fourth Industrial Revolution, Industry 4.0 Technologies
Unit – II Power Transmission	2a. Identify different mode of power transmission. 2b. Select suitable power transmission mode for given application. 2c. Identify the different types of Brake, Clutch and Coupling. 2d. Explain with sketches construction and working of given brake, clutch and coupling.	2.1. Power transmission: <ul style="list-style-type: none"> a. Importance. b. Modes (belt drives, rope drives, chain drives and gear trains). c. Types of belt and belt drive. d. Types of gear and gear train. e. Applications. 2.2. Brakes, Clutch and Coupling. <ul style="list-style-type: none"> a. Classification. b. Construction and working. c. Application.
Unit– III Machine Tools and Manufacturing Processes	3a. Identify basic machine tools. 3b. State operation performed on different machine tools. 3c. Explain concept of different metal joining processes. 3d. Describe the procedure for casting of given object. 3e. Explain concept of various	3.1. Basic machine tools. <ul style="list-style-type: none"> a. Introduction to lathe, drill, milling and grinding machines. b. Types of operations / jobs which can be performed on machine tools listed above. 3.2. Metal Joining Processes.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	metal forming processes.	3.2.1. Welding. a. Types. b. Working setup of arc and gas welding. c. Precautions and safety during arc and gas welding. 3.2.2. Brazing and Soldering. d. General set up. e. Applications. 3.3. Foundry. a. Concept. b. Process of casting a component. c. Applications. 3.4. Basic metal forming processes Bending, rolling, forging and extrusion – concept and its application
Unit– IV Thermal systems	4a. Explain steam formation process. 4b. Explain working of the given boiler. 4c. Describe the function of different mounting and accessories.	4.1. Steam generation. a. Steam formation process. 4.2. Boilers. a. Introduction. b. Classification. c. Construction and working of Cochran, Lancashire, and Babcock and Wilcox boiler. d. Functioning of different mountings and accessories.
	4d. Explain working of a given steam turbine. 4e. Identify the components of given type of IC Engine. 4f. Explain working of two stroke and four stroke petrol and diesel engine with sketches. 4g. State effect of air pollution due to IC engine.	4.3. Prime movers. a. Definition. b. Classifications. 4.4. Steam turbine -working and applications. 4.5. Internal combustion engines. a. Introduction. b. Classification. 4.6. Construction and Working of two stroke and four stroke petrol engine. 4.7. Construction and Working of two stroke and four stroke diesel engine. 4.8. Air pollution due to IC engines.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	4h. Identify the component of refrigeration and air conditioning systems. 4i. Differentiate refrigeration and air conditioning systems. 4j. Suggest the solution for energy saving in the given simple situation.	4.9. Refrigeration. a. Definition. b. Major components of refrigeration systems. c. Ton of refrigeration. d. Applications. 4.10. Air Conditioning. a. Definition. b. Properties of air. c. Types of air conditioning systems. (Window, Package, Central air conditioning system) 4.11. Methods of energy conservation in refrigeration and air conditioning systems.
Unit– V Hydraulic and Pneumatic Devices	5a. Explain different fluid properties. 5b. Describe construction, working and application of centrifugal and reciprocating pumps. 5c. Explain working and application of water turbines and air compressors. 5d. Describe working and application of other pneumatic/ hydro-pneumatic equipment.	5.1. Concept of theory of fluid flow. 5.2. General properties of fluids. 5.3. Pump. a. Working principle. b. Types. c. Construction and Working of centrifugal and reciprocating pumps. 5.4. Water turbines: a. Working principle. b. Types. c. Application. 5.5. Air compressor. a. Working principle. b. Types. c. Application. 5.6. Other hydraulic/pneumatic/ hydro-pneumatic equipment. a. Principle of working- hydraulic lift, hydraulic pump, hydraulic power pack, hydraulic jack. b. Application.
Unit– VI Material Handling Devices	6a. Identify different material handling equipment. 6b. Describe the procedure for selecting relevant material handling equipment.	6.1. Need of material handling. 6.2. Types, principle of working and applications of material handling equipment. a. Hoisting equipment. b. Conveying equipment.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		c. Surface & overhead equipment. d. Earth moving machineries. e. Construction machineries. 6.3. Criteria for selection of material handling equipment.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Tutorial Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic Mechanical Tools and Components	03	NOT APPLICABLE			
II	Power Transmission	03				
III	Machine Tools and Manufacturing Processes	06				
IV	Thermal Systems	10				
V	Hydraulic and Pneumatic Devices	04				
VI	Material Handling Devices	02				
Total		28				

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

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

- Student will visit the respective discipline industry / site and will prepare the list of mechanical engineering related equipment/machineries used by that industry / site.
- Prepare a seminar on casting Processes.
- Prepare a power point presentation on metal forming process.
- Prepare a list of household items which are made by joining processes.
- Prepare a chart on construction and working of various boilers.
- Visit a nearby automobile workshop and collect parts of IC engine from scrap.
- Prepare property table for different types of refrigerants/alternate fuels.
- Collect videos, animation showing working of various hydro/pneumatic devices.
- Visit a nearby industry and prepare a report on different types of material handling equipments.
- Students will visit the industry and collect the specification and features of different water turbine and submit the report.

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) Guide student(s) in undertaking micro-projects.
- c) **'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- d) About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- e) With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- f) Guide students on how to address issues on environment and sustainability

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-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 duration of the microproject should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) **Gear**: Build model of different gears from cardboard.
- b) **Boilers**: Build model of different mountings with suitable material.
- c) **IC Engine**: Build model of IC Engine parts from cardboard.
- d) **Casting**: Prepare cast product with wax material.
- e) **Pump**: Collect leaflets of pump from market, analyze and compare specifications.
- f) **Material Handling Equipment**: Collect information on different material handling equipment used in power plant/ construction site/Mining industries/Process industries/heavy manufacturing industries/ship building industries/aircraft industries from the internet.
- g) **Air conditioning and Refrigeration Controls** : Make models of controls demonstrating their functions at least 3 under guidance of instructor/teacher in lab/ workshop.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Theory of machine	R S Khurmi & J K Gupta	Eurasia Publishing House (Pvt.) Ltd. New Delhi, 2020 ISBN: 9788121925242
2	Elements of workshop Technology (Vol. 1,2)	S.K. Hajra chaudhary A.K. Hajra chaudhary	Media promoters & publishers Pvt.Ltd. Mumbai, 2010 ISBN: 9788185099156
3	Fluid mechanics and hydraulic machines	R.K. Bansal	Laxmi publication Pvt.Ltd. New Delhi, 2018 ISBN: 9788131808153
4	Material Handling equipment	N. Rundenko	Central Books Ltd, 1970, ISBN: 978-0714702858
5	Thermal Engineering	R.K. Rajput	Laxmi Publication Pvt.Ltd. New Delhi, 2018 ISBN: 9788131808047
6	A Textbook of thermal Engineering	R. S. Khurmi & J. K. Gupta	S. chand Limited, New Delhi, 2020, ISBN: 9788121925730
7	Basic Mechanical Engineering	Pravin Kumar	Pearson Education ,India, 2018 ISBN: 9789386873293
8	Basic Mechanical Engineering	S. C. Sharma & M.P. Poonia	Khanna Publishing, 2018 ISBN: 9789386173331

14. SOFTWARE/LEARNING WEBSITES

- <http://nptel.iitm.ac.in/>
- <https://www.khanacademy.org/>
- <http://learnerstv.in/>
- <https://www.youtube.com/watch?v=DGST2NvATKI> (Basic Mechanical tools)
- <https://www.youtube.com/watch?v=eRfTZpEmnys&t=6s> (Hand Tools)
- <https://www.youtube.com/watch?v=RdipnvBPOKU> (Power Tools)
- <https://www.youtube.com/watch?v=r3f7klDFwrU> (Gears)
- <https://www.youtube.com/watch?v=EduTT7xzZg&t=144s> (Power Transmission Mode)
- <https://www.youtube.com/watch?v=MYhe3KSKKiU> (Operations of lathe machine)
- https://www.youtube.com/watch?v=Nao_mLIh5dk (Welding)
- <https://www.youtube.com/watch?v=EIBDp6U8bHo> (Foundry)
- https://www.youtube.com/watch?v=Um_g8sQ_p3Y (Manufacturing Processes)
- <https://www.youtube.com/watch?v=dVBoZ4PfZmE> (Boiler)
- https://www.youtube.com/watch?v=_ui143hJCK4 (IC Engine Parts)
- <https://www.youtube.com/watch?v=Pu7g3ulG6Zo&t=18s> (Four stroke Engine Working)
- <https://www.youtube.com/watch?v=h5wQoA15OnQ> (Refrigeration)
- <https://www.youtube.com/watch?v=gVLhrLTF878> (Air Conditioning)
- <https://www.youtube.com/watch?v=BaEHVpKc-1Q> (Pump)
- <https://www.youtube.com/watch?v=7ul7G8csJSM> (Pump)

- <https://www.youtube.com/watch?v=VoUtTjtA5vE> (Compressor)
- <https://www.youtube.com/watch?v=M08LCcVAuUY> (Material Handling equipment)

15. PO-COMPETENCY-CO MAPPING

Semester I & II	Basics of Mechanical Engineering (Course Code: 4300017)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Apply basic principles of mechanical engineering in various engineering applications.						
Course Outcomes							
CO a) Use relevant mechanical power and hand tools in real life applications.	3	1	1	3	2	1	3
CO b) Select relevant power transmission mode in simple engineering situation.	3	2	1	1	2	1	2
CO c) Use relevant manufacturing process for various components.	2	1	3	2	2	2	2
CO d) Identify different components of various thermal systems.	3	2	1	1	2	1	2
CO e) Identify various hydro-pneumatic devices/ equipment.	2	2	1	2	1	2	2
CO f) Use material handling equipment for given situations.	2	2	2	2	2	1	3

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
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