

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- A) Course Code : 2037571(037)
B) Course Title : Automobile Engineering
C) Pre-requisite Course Code and Title :
D) Rationale :

A diploma holder in mechanical engineering should have an overall view of automobiles before learning the detail aspects of various systems of automobile. This subject provides a broad knowledge about the automotive engines, electrical system, transmission, final drive, braking system, front axle, steering, frame and chassis. This knowledge will be helpful to the students in co-relating various systems with each other and understanding the individual systems in a better manner.

E) Course Outcomes:

- CO-1 Identify the vehicle layout and automobile engines.
CO-2 Prepare electrical and electronic circuits for different automobile applications.
CO-3 Select Brakes, Clutch and Suspension system for different application.
CO-4 Select transmission system for different applications.
CO-5 Use relevant Steering, Front Axle, wheels and tyre system for different application
CO-6 Use control measures to control the harmful emissions.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+(P/2)
1	Mechanical Engineering	2037571(037)	Automobile Engineering	2	-	1	3
2	Mechanical Engineering	2037561(037)	Automobile Engineering (Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037571(037)	Automobile Engineering	70	20	30	-	-	120
2	Mechanical Engineering	2037561(037)	Automobile Engineering (Lab)	-	-	-	30	50	80

- Note:** i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
 ii. Separate passing is must for End Semester Exam (Theory) and End Semester Exam (Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Identify the vehicle layout and automobile engines.

(Approx. Hrs: L+P+T=16)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Identify the Vehicle Layouts and its type for the given vehicle. SO1.2 Draw the layout of the given vehicle. SO1.3 Identify the automobile components on the given vehicle. SO1.4 Explain with sketch the functions of the given automobile components. SO1.5 Describe with sketch the construction and working of given engine. SO1.6 Describe with sketch the construction and working of different components of the	LE1.1 Identify vehicle layout and its chassis. LE1.2 Dismantle internal combustion engines of the given vehicle. LE1.3 Assemble Internal combustion engines of the given vehicle LE1.4 Dismantle the Carburetor of the given vehicle. LE1.5 Assemble the Carburetor of the given vehicle. LE1.6 Identify the location of engine in the given vehicle. LE1.7 Identify different	Unit1.0 Essentials of Automobile 1.1 Introduction, classification of automobiles, Types of automobiles. Two wheeler/Light Commercial Vehicle/Sport Utility Vehicle/Heavy commercial Vehicles 1.2 Layout of automobile, importance of vehicle layout, types of vehicle layout (FEFWD, FERWD, RERWD, 4WD), Advantages, Disadvantages, Applications and Comparisons of Different types of vehicle layouts, Major components of the automobile and its functions and location.	<ul style="list-style-type: none"> Modern carburetor like: Cartor carburetor, S.U. Carburetor Self starter (Bendix Drive) Electric motor, Fuel cell (Hydro/Hydro methanol fuel cell) views.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
given engine.	<p>constructional features of given petrol engine.</p> <p>LE1.8 Identify different constructional features of given diesel engine.</p>	<p>1.3 Layout of chassis, Frame and Body:</p> <ul style="list-style-type: none"> Requirement of Chassis, classification of chassis. Function of Chassis Frame and Body, Load acting on Frame, advantages, disadvantages and applications of different types of chassis, Basic Body Nomenclature. <p>1.4 Significance of Body Streamlining: Need and Importance of Aerodynamic Aspects, Basic terms related with Car Aerodynamics (e.g. Drag, Lift, Skin Friction, Form Drag, Wake, Coefficient of Drag etc.)</p> <p>Automotive engines</p> <p>1.5 Types of Automobile Engines: Petrol Engine, Diesel Engine.</p> <p>1.6 Engines locations - front, rear and transverse under floor with their advantages and disadvantages.</p> <p>1.7 Engine Constructional features : Engine block, engine heads, crank case oil pan, cylinder liners, Gasket, combustion chambers with their types, piston, piston pin, gudgeon pin, connecting rod, crank shaft, cam shaft, Valve & valve mechanism. Valve timing / port timing diagram, timing gears, Inlet & Exhaust mufflers, concept of firing order in multi-cylinder engine.</p> <p>1.8 Lubrication and cooling.</p>	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

SW-1 Suggested Sessional Work (SW):

a. Assignments:

- Compare Different Types Of Automobile Engines And Its Major Components.
- Prepare a Power point presentation on automobile chassis and frames.

b. Mini Project:

- Collect the samples of different types of lubricants (at least 05 samples) from the market and prepare a report on the basis of properties of lubricant, use of lubricant, condition in which lubricants can be used, etc.
- Prepare a report on various aerodynamic designs of passenger cars available in the market on the basis of Drag, Lift, Skin Friction, Form Drag, Wake, Coefficient of Drag etc. and its effect on car speed.

c. Other Activities (Specify):

- Prepare a presentation on different types of automobile layout and its comparison.

CO-2 Prepare electrical and electronic circuits for different automobile applications.

(Approx. Hrs: L+P+T=11)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Explain with sketch the construction and working of Fuel Supply System of the given vehicle.	LE2.1 Dismantle & assemble the Carburetor.	Unit-2.0 Fuel supply system and auto-electric and electronic 2.1 Introduction of fuel system for petrol engine. Gravity feed system, Fuel pump, Simple and Solex carburetor. 2.2 Concept of Petrol Injection (Mechanical and Electronic injection systems) & MPFI Petrol injection systems. Concept of supercharging. 2.3 Introduction of fuel system for diesel engine 2.4 Concept of Fuel injection systems and Its Construction, Working of Fuel injection pump and their types, Fuel injector. Electrical and Electronic system 2.5 Basic Electrical-Electronics Components used in automobiles with their conventional symbols. 2.6 Main Components of the Electrical and electronic	<ul style="list-style-type: none"> Automobile battery maintenance.
SO2.2 Select fuel supply system for the given application with justification	LE2.2 Identify the electrical and electronics part of the given vehicle.		
SO2.3 Describe with sketch Auto-Electric System of the given vehicle.	LE2.3 Dismantle and assemble the given fuel supply system.		
SO2.4 Draw electrical and electronic circuit of the given vehicle.	LE2.4 Identify the different parts of fuel injection system		
SO2.5 Explain with sketch the construction and working of fuel injection system.	LE2.5 Test a Lead Acid Battery for Open Voltage and Specific Gravity.		
SO2.6 Select relevant lead acid battery for the given application.	LE2.6 Dismantle reassemble the Distributor used in Battery Ignition System.		
SO2.7 Explain the working principle of Alternator for the given vehicle.	LE2.7 Prepare a simple electrical circuit for Automobile applications like Lighting/Horn/Wiper/Flasher/Indicators.		
SO2.8 Differentiate between Battery and Magneto Ignition System on the basis of the given parameters.			

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>SO2.9 Select the appropriate sensors and actuators for the given application with justification.</p> <p>SO2.10 Select relevant alternative fuel for the given application with justification</p> <p>SO2.11 Prepare the layout of the vehicle operated on alternative fuels</p>		<p>System. Function of Starting and charging systems, construction and Working of Alternator.</p> <p>2.7 Ignition System, Function and Requirement of Ignition System, Distributor, Ignition Coil, Ignition Timing, Ignition Advance, coil and Electronic Ignition System.</p> <p>2.8 Lighting system, Automobile Battery- Function of Battery, Types of Battery, Principle of Lead Acid Battery, Construction and Operation of Lead Acid Battery Low-maintenance and Maintenance-free Batteries., Significance of Battery Rating & Battery Capacity, Battery Open Volt and Specific Gravity Test. Types of Lights, Necessity and Importance of Cable Color Codes, Wiring Harness.</p> <p>2.9 Different types of Gauges, Windscreen wiper, Function & Location of Major Sensors and Actuators used in Automobile Electronics</p>	

SW-2 Suggested Sessional Work (SW):

a. Assignments:

- i. Compare different ignition system and its related parameter.
- ii. Differentiate between different types of fuel supply system of petrol and diesel engine.

b. Mini Project:

- i. Troubleshoot a given fuel supply/auto-electric system and submit the report.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- ii. Visit to nearby automobile workshop and identify the different types of sensors and actuators used in a passenger car (at least 05 different companies passenger car) and prepare a report on the basis of its location, types, functions, specifications, numbers etc.

CO-3 Select Brakes, Clutch and Suspension system for different application.

(Approx. Hrs: L+P+T=14)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>SO3.1 Describe with sketch the construction and working of given type of braking system.</p> <p>SO3.2 Describe with sketch the construction and working of given clutch.</p> <p>SO3.3 Describe with sketch the construction and working of the given suspension system.</p> <p>SO3.4 Draw layout of the given Hydraulic and Air Braking System.</p> <p>SO3.5 Identify the different components of the given ABS.</p> <p>SO3.6 Select clutch and brakes for the given situation with justification.</p> <p>SO3.7 Explain with sketch the given type of ABS system</p> <p>SO3.8 Explain the concept of Air Suspension for the given vehicle.</p> <p>SO3.9 Explain Front Axle assembly.</p>	<p>LE3.1 Dismantle and assemble of the given brake assembly.</p> <p>LE3.2 Dismantle and assemble the given clutch assembly.</p> <p>LE3.3 Dismantle, inspect and reassemble the Differential Assembly</p> <p>LE3.4 Dismantle, inspect and reassemble the Drum/Disc Brake</p> <p>LE3.5 Identify the electronic and electrical parts used in the given engine.</p> <p>LE3.6 Dismantle and assemble the given suspension system.</p> <p>LE3.7 Identify the different components and basic features of Independent Suspension System for the given vehicle.</p>	<p>Unit-3.0 Brakes, Clutch and Suspension systems</p> <p>(a) Brakes</p> <p>3.1 Need & function of braking system, principle of braking system, Brake efficiency, stopping distance and basic terms related to braking.</p> <p>3.2 Electric and Electronic technology used in braking system</p> <p>3.3 Foundation brakes - drum and disc brakes, Hydraulic and pneumatic brakes, Self energized brakes, Power brakes, Air brakes, Emergency & Parking Brakes</p> <p>3.4 Floating-caliper brakes, ceramic pads, twin brake disc systems, hybrid systems, coated discs, anti-squeal technology</p> <p>3.5 Electronic brakes - EPB (electric park brake), ESP (electronic stability control), braking assistance, predictive braking, brake-by-wire, slip control, regenerative braking, autonomous emergency braking</p> <p>3.6 Anti lock braking System: Layout of ABS, Pressure Modulation, and Types of ABS.</p> <p>3.7 Electric Driven Intelligent Brake-construction, working and its function</p> <p>3.8 Construction and Working of Master Cylinder, Wheel Cylinder, Tandem Master Cylinder, Significance and general procedure of Bleeding of Brake.</p> <p>(b) Clutch system</p> <p>3.9 Need and function of clutch</p>	<ul style="list-style-type: none"> • Brake trouble shooting. • Clutch trouble shooting. • Suspension repair and maintenance.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		<p>system, construction and working of clutch system, classification of clutch</p> <p>3.10 Types of clutch systems</p> <p>3.11 Single plate and multi plate clutch, Centrifugal clutch, Semi centrifugal clutch</p> <p>3.12 AMTs (automate manual transmission), CVTs, DCTs (direct-shift, Hybrids clutch.</p> <p>(c) Suspension system</p> <p>3.13 Function of Suspension system, construction and working of Suspension system, classification of Suspension system, Types of suspensions used in automobiles.</p> <p>3.14 Function and Requirement of Rigid Suspension System: Basic Terms - Jounce, Rebound, Sprung and Unsprung Weight, Spring Rate, Elasticity, Types and Constructional Features of Leaf Springs,</p> <p>3.15 Function of Independent Suspension System, Advantages of Front Wheel Independent Suspension, Construction and Working of Mac-Pherson Strut Type, Wishbone Type Suspension system.</p> <p>3.16 Shock Absorbers and Air Suspension: Layout, Construction and Working of Air Suspension, Function and Types of Shock Absorber, Principle of Hydraulic Shock Absorber, Construction and Working of Telescopic Shock Absorber, Constructional Features & working of Gas Filled Shock Absorber</p>	

SW-3 Suggested Sectional Work (SW):

a. Assignments:

- i. Identify merits and demerits of different braking system used in automotive system.
- ii. Prepare merits and demerits of different clutch system used in automotive system.

b. Mini Project:

- i. Visit to the nearby service center and prepare a report on various types of brake used in two wheeler/Light Commercial Vehicle/Sport Utility Vehicle/Heavy commercial Vehicles on the basis of types of brakes used, function, working, types of fault occurs, method of fault diagnosis, reason for fault occurrence and its rectification etc.

c. Other Activities (Specify):

- i. Give a seminar on automobile brakes, clutches, suspension system, shock absorber etc.

CO-4 Select transmission system for different applications.

(Approx. Hrs: L+P+T=18)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>SO4.1 Describe with sketch the concept of given road resistance with example</p> <p>SO4.2 Explain with sketch the construction and working of given Transmission system.</p> <p>SO4.3 Explain with sketch the construction and working of given shaft.</p> <p>SO4.4 Draw power flow diagrams of transmission.</p>	<p>LE4.1 Dismantle & assemble the gear boxes in the vehicle.</p> <p>LE4.2 Dismantle and assemble differential system.</p> <p>LE4.3 Identify different rear axle shaft and its drives from the given sample.</p> <p>LE4.4 Identify different type of gearboxes from the given sample</p>	<p>Unit-4.0 Automobile Transmission system</p> <p>4.1 Need and functions of transmission system.</p> <p>4.2 Concept of various road resistances such as wind, Gradient, Resistance, Total resistance, Tractive- effort.</p> <p>4.3 Types of transmission systems.</p> <p>4.4 Need of gear box, function and working of gear box, construction of gear box, types of gear boxes - sliding mesh. Constant mesh, synchromesh gear boxes, mathematical analysis of gear boxes, Gear shifting mechanisms, five speed gear box.</p> <p>4.5 Function , construction and working of Torque converter, Overdrive automatic transmission, fluid flywheel and epicyclic gear trains.</p> <p>4.6 Functions of propeller shaft, types of propeller shaft, Universal joints & slip joints on propeller shaft.</p> <p>4.7 Function & need of differential Final drive and differential</p> <p>4.8 Axles: function and need of axles, types of axles,</p> <ul style="list-style-type: none"> • Function and need of rear axle such as semi floating, fully floating, Three quarter floating. • Rear axle drives such as 	<ul style="list-style-type: none"> • Types of gears used in differential. • Differential trouble diagnosis.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		Hotchkiss type, torque tube type. • Function and need of Front Axle, Types of (Front) Stub axle	

SW-4 Suggested Sectional Work (SW):

a. Assignments:

- i. Prepare a comparative report on different types of gearbox used in automobiles.
- ii. Explain the effect of various road resistances like wind, Gradient, Resistance, Total resistance, Tractive- effort on the performance of the vehicle.

b. Mini Project:

- i. Visit any two different companies four wheeler service center and prepare a comparative report on the types of axle used, its functions, need and application and also identify the advantage and disadvantage of using the specific axles in different four wheeler.
- ii. Visit any two different companies four wheeler service center and prepare a comparative report on the types of gear box used, its functions, need and application and also identify the advantage and disadvantage of using the specific gear box in different four wheeler.

CO-5 Use relevant Steering, wheels and tyre system for different application.

(Approx. Hrs: L+P+T=11)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Describe with sketch the construction and working of the given steering system, SO5.2 Describe with sketch the function, major features and application of the given tyre. SO5.3 List the different components of steering linkages with their function in the given steering mechanism SO5.4 Explain the working principle of Power Steering System for the given vehicle. SO5.5 Draw labeled diagrams of steering geometry.	LE5.1 Disassembly and assembly of the steering system. LE5.2 Identify different components of steering linkages in the given steering mechanism. LE5.3 Dismantle, and reassemble the Steering Gear box. (Rack & Pinion/Re-circulating Type/Worm and Wheel) LE5.4 Dismantle, and reassemble the Power Steering system. (Hydraulic/Electronic Type) LE5.5 Remove, inspect and refit the Wheel and Tyre assembly. LE5.6 Perform the wheel alignment and balancing of the given vehicle. LE5.7 Identify different types of tyres, wheel and rim from the given samples.	Unit-5.0 Automobile Steering and Tyre system (a) Steering system 5.1 Function of the steering system, Steering wheel & column, Basic Terms related to Steering- Steering Ratio, Turning Radius, Under steering and Over steering, Basic Components of Steering Linkages 5.2 Steering geometry, adjusting the steering angles, Ackerman principle. 5.3 Construction and Working of Rack and Pinion, Re-circulating Ball Type Steering Gear Box 5.4 Power steering, Principle of Power	<ul style="list-style-type: none"> Steering gears & Steering mechanism used in some Indian vehicles, Tyre Service Parameters, Tyre Maintenance

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>SO5.6 Explain the tyre designation system for the given vehicle.</p> <p>SO5.7 Select appropriate procedure, tool and equipment for Wheel Alignment and Balancing for the given vehicle with justification.</p> <p>SO5.8 Explain the given tyre designation</p> <p>SO5.9 Select relevant steering system for the given application with justification.</p> <p>SO5.10 Select relevant tyre and wheel for the given application with justification.</p>		<p>Steering, Steering lock, Construction and Working of Hydraulic and Electronic Power Steering.</p> <p>5.5 Significance and ranges of Caster (Positive, Negative), Camber (Positive, Negative), Toe-in, Toe out, King Pin Inclination (KPI), Steering Axis Inclination (SAI)</p> <p>5.6 Steering trouble shooting</p> <p>(b) Tyre system</p> <p>5.7 Types of Automobile Wheels, Rims and Tyres, Construction and Working of Different Types of Wheels, Rims and Tyres, specifications. Criteria for Selection of tyre.</p> <p>5.8 Wheel alignment and balancing, procedure of Wheel Alignment, Purpose of Wheel Balancing, Significance of Static and Dynamic Balancing, Procedure for Static and Dynamic Balancing.</p> <p>5.9 Tyre Economy: Consideration in Tyre Tread Design, Factors affecting to Tyre Life, Tyre Wear and Rotation, Tyre Designation.</p>	

SW-5 Suggested Sectional Work (SW):

a. Assignments:

- i. Explain the effect of different parameters the tread of various types tyres.
- ii. Describe the parameters which effect the performance of front axle.

b. Mini Project:

- i. Visit nearby automobile service center and prepare report on wheel alignment of four wheeler.
- ii. Compare the steering geometry of 05 different companies passenger car and prepare a report consisting of figures, comparison, steering performance, effect on vehicle performance, ergonomics etc.

c. Other Activities (Specify):

- i. Visit a cold storage. Prepare its layout and list down the specifications of different equipments used.
- ii. Visit a milk chilling plant. Prepare its layout and list down the specifications of different equipments used.

CO-6 Use control measures to control the harmful emissions.

(Approx. Hrs: L+P+T=10)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO6.1 Differentiate between complete and incomplete combustion on the basis of given parameters. SO6.2 Explain the effect on exhaust emission due to various parameters. SO6.3 Select relevant alternative fuel for the given application with justification SO6.4 Prepare the layout of the vehicle operated on alternative fuels SO6.5 Identify Road Traffic signs. SO6.6 List the Safety systems used in Modern automobiles. SO6.7 Explain the different parameter which affects the passenger safety.	LE6.1 Use Exhaust gas Analyzer to investigate the characteristic of petrol & diesel exhaust gas LE6.2 Determine the characteristics of the given fuel.	Unit-6.0 Automobile Emissions and its Control 6.1 Introduction, Complete and Incomplete Combustion. 6.2 Constituents of Exhaust Gases, Pollutant Formation 6.3 Effect of Air Fuel Ratio on Exhaust Emission, Effect of Driving Mode on Exhaust Emission, Sources of Pollutants in an Automobile 6.4 Control Approaches for Automobile Emission 6.5 Muffler, Alternative Fuels- Layout of Vehicle operated on Natural Gas (LPG & CNG): Need, Fuel Characteristics, Construction & Working, Advantages, and Limitations. Layout of Electric Vehicles: Need, Working, Advantages, Limitations. Hydrogen as fuel. 6.6 Motor Vehicle Act Salient Features of M. V. Act 1988 and Central Motor Vehicle Rules 1989. 6.1.2, Types and Significance of Traffic Signs, Important Transport Terms in M. V. Act (Motor Vehicle, Motor Cycle, HGV, MG, LGV, Public Service Vehicle, Transport Vehicle, Driver, Passenger, Accident) 6.7 Passenger Comfort and Safety, Function and requirements of	<ul style="list-style-type: none"> Emission Control Technologies In Automotive & Transportation Advancement of Fuel Quality and Vehicle Emissions Norms.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		Passenger Safety System. Features of Air Bags, Seat Belts, Collapsible Steering Column.	

SW-6 Suggested Sectional Work (SW):

a. Assignments:

- Conduct trial on petrol & diesel exhaust gas Analyzer & analyze the results.

b. Mini Project:

- Visit nearby automobile pollution checks and control center and prepare report on Method of checking the emission, Constituents of Exhaust Gases, Pollutant Formation, Effect of Air Fuel Ratio on Exhaust Emission, Control Approaches adopted for Automobile Emission etc.
- Visit to the nearby automobile workshop and prepare a report on Layout of 04 different Electric Vehicles: difference, Need, Working, Advantages & Limitations.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Essentials of Automobile	2	3	5	10
II	Fuel supply system and auto-electric and electronic	1	4	5	10
III	Brakes, Clutch and Suspension systems	3	4	8	15
IV	Automobile Transmission system	3	5	7	15
V	Automobile Steering and Tyre system	1	3	6	10
VI	Automobile Emissions and its Control	1	3	6	10
Total		11	22	37	70

Legend: R: Remember, U: Understand, A: Apply and above

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE 1.1	Identify vehicle layout and its chassis.	15	10	5
LE 1.2	Dismantle internal combustion engines of the given vehicle.	15	10	5
LE 1.3	Assemble Internal combustion engines of the given vehicle	15	10	5
LE1.4	Dismantle the Carburetor of the given vehicle.	20	5	5
LE1.5	Assemble the Carburetor of the given vehicle.	15	10	5
LE1.6	Identify the location of engine in the given vehicle.	15	10	5
LE1.7	Identify different constructional features of given petrol engine.	15	10	5
LE1.8	Identify different constructional features of given diesel engine.	15	10	5
LE2.1	Dismantle & assemble the Carburetor.	15	10	5
LE2.2	Identify the electrical and electronics part of the given vehicle.	15	10	5
LE 2.3	Dismantle and assemble the given fuel supply system.	15	10	5
LE 2.4	Identify the different parts of fuel injection system	15	10	5
LE 2.5	Test a Lead Acid Battery for Open Voltage and Specific Gravity.	15	10	5
LE 2.7	Dismantle reassemble the Distributor used in Battery Ignition System	15	10	5
LE 2.8	Prepare a simple electrical circuit for Automobile applications like Lighting/Horn/Wiper/Flasher/Indicators.	15	10	5
LE 3.1	Dismantle and assemble of the given brake assembly.	15	10	5
LE 3.2	Dismantle and assemble the given clutch assembly.	15	10	5
LE 3.3	Dismantle, inspect and reassemble the Differential Assembly	15	10	5
LE 3.4	Dismantle, inspect and reassemble the Drum/Disc Brake	15	10	5
LE 3.5	Identify the electronic and electrical parts used in the given engine.	15	10	5
LE 3.6	Dismantle and assemble the given suspension system	15	10	5
LE 3.7	Identify the different components and basic features of Independent Suspension System for the given vehicle	15	10	5
LE 4.1	Dismantle & assemble the gear boxes in the vehicle.	15	10	5
LE 4.2	Dismantle and assemble differential system.	15	10	5
LE 4.3	Identify different rear axle shaft and its drives from the given sample.	15	10	5
LE 4.4	Identify different type of gearboxes from the given sample	15	10	5
LE 5.1	Disassembly and assembly of the steering system.	15	10	5
LE5.2	Identify different components of steering linkages in the given steering mechanism.	15	10	5
LE5.3	Dismantle, and reassemble the Steering Gear box. (Rack & Pinion/Recirculating Type/Worm and Wheel)	15	10	5
LE5.4	Dismantle, and reassemble the Power Steering system. (Hydraulic/Electronic Type.	15	10	5
LE5.5	Remove, inspect and refit the Wheel and tyre assembly.	15	10	5
LE5.6	Perform the wheel alignment and balancing of the given vehicle.	15	10	5
LE5.7	Identify different types of tyres, wheel and rim from the	15	10	5

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	given samples.			
LE 6.1	Use Exhaust gas Analyzer to investigate the characteristic of petrol & diesel exhaust gas	15	10	5
LE 6.2	Determine the characteristics of the given fuel.	15	10	5

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30** Marks as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Industrial visits
4. Industrial Training
5. Field Trips
6. Demonstration
7. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Automotive Engineering Vol I & II.	Kirpal Singh	Standard publishers and distributors, New Delhi	2012
2.	Automotive Mechanics	Crouse & Anglin	McGraw Hill Education, New Delhi	10 2017
3.	Automobile Engineering	Jain K.K., Asthana R.B.	McGraw Hill Education, New Delhi	1st 2017
4.	Modern automotive technology	James E. Duffy	Goodheart-Willcox, New Delhi	8th 2013
5.	Automotive Technician Certification Test Preparation Manual	Knowles Don	Delmar Thomson Learning, New Delhi (Delmar Cengage Learning)	3rd Revised edition 1 Oct 2006
6.	Internal Combustion Engine	Mathur M.L., Sharma R.P.	Dhanpat Rai & Sons, New Delhi	1st Jan 2014
7.	Basic Automobile Engineering	Nakra C.P.	Dhanpat Rai & Sons, New Delhi	Nineteen Edition 2015
8.	Vehicle body layout and analysis	John Fanton	Institution Of Mechanical Engineers	1st October 1980
9.	Auto mechanic Understanding the New Technology	Don Knowles	Brady Publisher, New Delhi	1987

(b) Open source software and website address:

Unit 1- Vehicle layout and automotive engines

- i. <https://www.youtube.com/watch?v=HaTO67c7haQ>
- ii. https://en.wikipedia.org/wiki/Car_layout
- iii. <https://www.youtube.com/watch?v=rki-8rJ7zIQ>
- iv. <https://www.youtube.com/watch?v=qPmfnC36YEA>
- v. <https://www.carparts.com/engine.htm>
- vi. <https://www.youtube.com/watch?v=FcRyFHPZNQo>
- vii. https://www.youtube.com/watch?v=zA_19bHxEYg

Unit 2- Electrical and electronic circuits

- i. <https://www.youtube.com/watch?v=Nq5mnn9xMGM>
- ii. <https://www.youtube.com/watch?v=hAjM9Gk63M4>
- iii. https://en.wikipedia.org/wiki/Automotive_electronics
- iv. <https://www.youtube.com/watch?v=nQXOtX1AFuM>
- v. <https://www.howacarworks.com/basics/how-car-electrical-systems-work>

Unit 3- Brakes, Clutch and suspension system

- i. <https://en.wikipedia.org/wiki/Brake>
- ii. <https://www.youtube.com/watch?v=xCw6eXwxn2A>
- iii. <https://www.youtube.com/watch?v=awd4bLKcUls>
- iv. <https://en.wikipedia.org/wiki/Clutch>
- v. <https://www.youtube.com/watch?v=devo3kdSPQY>
- vi. [https://en.wikipedia.org/wiki/Suspension_\(vehicle\)](https://en.wikipedia.org/wiki/Suspension_(vehicle))
- vii. <https://www.youtube.com/watch?v=MraNBaCmcok>

Unit 4- Transmission system

- i. https://www.youtube.com/watch?v=u_y1S8C0Hmc
- ii. [https://en.wikipedia.org/wiki/Transmission_\(mechanics\)](https://en.wikipedia.org/wiki/Transmission_(mechanics))
- iii. <https://www.youtube.com/watch?v=RQWejyx0gi8>

Unit 5- Steering, Front Axle, wheels and tyre system

- i. <https://www.youtube.com/watch?v=em1O8mz7sF0>
- ii. <https://en.wikipedia.org/wiki/Steering>
- iii. <http://what-when-how.com/automobile/steering-systems-automobile/>
- iv. <https://www.youtube.com/watch?v=e7d1kOnHIdA>
- v. <http://what-when-how.com/automobile/front-axle-automobile/>
- vi. <https://www.youtube.com/watch?v=uLW7WnaVFhQ>
- vii. https://www.youtube.com/watch?v=wnKci_kn_EU

Unit 6- Emission and its control

- i. <https://www.youtube.com/watch?v=qBD2XjejCEI>
- ii. <https://www.youtube.com/watch?v=EDqhQWYFW7g>
- iii. https://en.wikipedia.org/wiki/Vehicle_emissions_control

(c) Others:

1. Learning Packages.
2. Lab Manuals.
3. Manufacturers' Manual
4. Users' Guide

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Car chassis for educational purpose	Chassis of any car model	LE1.1
2	Cut section of car engine petrol	Car engine Petrol: Motor Driven (Fitted with F.H.P. 220 Volts AC Motor)	LE1.2, LE1.3, LE1.6
3	Cut section of car engine diesel	Car engine Diesel: Motor Driven (Fitted with F.H.P. 220 Volts AC Motor)	LE1.8,
4	Automotive electrical circuit	The circuit board module should be neatly laid out to represent typical automotive electrical circuits with electrical components, solenoid, relay, dc motor, switches and lights.	LE 2.2, LE2.7
5	Fuel supply systems of automobile		LE4.1
6	Fuel injection trainer - multi point EFI system	<p>The following components should be included in Multi point EFI System Trainer:</p> <p>A. Prime Components and Systems Electronic Control Unit (ECU) Test Point Panel for ECU Input/Outputs Fuel Tank Reservoir, Electric Fuel Pump with pressure gauge, Fuel Filter Fuel Distributor rail with pressure gauge, Fuel Injectors, Fuel Pressure Regulator, Graduated Fuel Volume Meter for each Injector, Complete Ignition System (detailed below) Variable speed drive for ignition with Tachometer, Silk-screened engine Diagram showing layout of components Throttle position sensor, Mass Air Flow Sensor, Complete system sensors, Sensor controls with meters, Electrical relays and control devices</p> <p>B. Sensors and Actuators Mass Air Flow Sensor or map sensor Intake Air Temperature sensor Throttle Position sensor Crankshaft Position and Engine Speed sensor, Engine Temperature (coolant) sensor, Lambda sensor</p> <p>C. Ignition System Ignition Coil, Ignition Distributor or Distributor less ignition, Infinitely Variable Drive System for distributor Spark Plugs, Set of High Tension Leads</p> <p>D. System Controls and Devices Key Ignition switch with pilot lights System Relays, Electronic Control Unit (ECU), Engine Speed Control Air Flow Control, Throttle position Control, Intake Air Temperature Control Engine Temperature (coolant) Control</p>	LE2.4

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
		Lambda (Oxygen) Control, Battery Voltage Control E. Meters and Gauges Mass Air Flow meter, Throttle Position meter, Intake Air Temperature meter Engine (coolant) Temperature meter Engine Speed Tachometer (RPM) Lambda (Oxygen) meter, Battery Voltage meter, Fuel Pump pressure gauge, Fuel Rail pressure gauge F. 12 VDC Regulated Power Supply, 30 Amps	
7	Lead-Acid Battery		LE2.5
8	Ignition and charging system	The trainer should be neatly laid out to represent the typical automobile ignition systems with distributor model, ignition coils, ignition circuit, alternator model, spark plugs model, camshaft and crankshaft sensor circuit and part of engine control unit (related to ignition system).	LE2.6
9	Cut section model of steering of jeep with stub axle	This model is made out of original used parts, will be suitably sectioned And Arranged to demonstrate the internal construction details showing the minute information such as steering gear box, bell assembly, tyre rod , linkages, stub axle etc.	LE5.1
10	Cut section model of steering gear box(working) with wheel and axle	This model is made out of full size original parts, suitably sectioned and to demonstrate the working of Steering wheel worms, Steering arm, etc	LE5.3
11	Power steering		LE5.4
12	Gear box working models	Actual cut section of Gear Box: 5 forward and 1 reverse	LE4.1, LE4.2, LE4.4
13	Working models of different brakes	1. Actual working model of shoe brake. 2. Actual working model of Disc brake	LE3.1
14	Actual cut section carburetors & automobile parts	1. Carburetor of any two wheeler model. 2. Carburetor of any car model	LE1.4, LE1.5, LE2.1
15	Models of different clutches	1. Single Plate clutch. 2. Multi plate clutch 3. Cone clutch	LE3.2
16	Differential system	Cut section model of fully floating differential and rear wheel mechanism (working)	LE3.3
17	Drum brake	Cut section model of drum brake unit (hydraulic working)	LE3.4
18	Disc brake	Cut section model of disc brake system	LE3.4
19	Suspension system		LE3.6, LE3.7
20	Rear axle shaft	Different rear axle shaft	LE4.3
21	Exhaust gas Analyzer	WHICH CAN measure the concentration of automobile emission gas CO ,CO ₂ , HC ,O ₂ and NO (optional)	LE 6.2

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1 Modern Software Usage	PSO-2 Equipment and Instruments	PSO-3 Mechanical Engineering Processes
CO-1 Identify the vehicle layout and automobile engines.	3	3	1	1	1	1	1	1	1	2	1	1	1
CO-2 Prepare electrical and electronic circuits for different automobile applications	3	3	3	2	1	1	1	2	2	2	2	3	1
CO-3 Select Brakes, Clutch and suspension system for different application.	3	3	1	1	1	2	1	1	1	2	1	1	1
CO-4 Select transmission system for different applications	3	3	1	1	1	2	1	1	1	2	1	1	1
CO-5 Use relevant Steering, Front Axle, wheels and tyre system for different application	3	3	3	2	1	2	1	2	2	2	2	3	1
CO-6 Use control measures to control the harmful emissions	3	3	3	2	1	2	1	2	2	2	2	3	1

Legend: 1 – Low, 2 – Medium, 3 – High

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,4,5,6,7,8,9,10 PSO-1,2,3	CO-1 Identify the vehicle layout and automobile engines.	SO1.1 - SO1.6	LE1.1 - LE1.8	Unit-1.0 Essentials of Automobile 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8	As mentioned in relevant page numbers.
PO-1,2,3,4,5,6,7,8,9,10 PSO-1,2,3	CO-2 Prepare electrical and electronic circuits for different automobile applications	SO2.1 - SO2.11	LE2.1 - LE2.8	Unit-2.0 Fuel supply system and auto-electric and electronic 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8	
PO-1,2,3,4,5,6,7,8,9,10 PSO-1,2,3	CO-3 Select Brakes, Clutch and suspension system for different application.	SO3.1 - SO3.9	LE3.1 - LE3.7	Unit-3.0 Brakes, Clutch and Suspension systems 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,3.10,3.11,3.12,3.13,3.14,3.15,3.16	
PO-1,2,3,4,5,6,7,8,9,10 PSO-1,2,3	CO-4 Select transmission system for different applications	SO4.1 - SO4.4	LE4.1 - LE4.4	Unit-4.0 Automobile Transmission system 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8	
PO-1,2,3,4,5,6,7,8,9,10 PSO-1,2,3	CO-5 Use relevant Steering, Front Axle, wheels and tyre system for different application	SO5.1 - SO5.12	LE5.1 - LE5.7	Unit-5.0 Automobile Steering and Tyre system 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	
PO-1,2,3,4,5,6,7,8,9,10 PSO-1,2,3	CO-6 Use control measures to control the harmful emissions	SO6.1 - SO6.7	LE6.1 LE6.2	Unit-6.0 Automobile Emissions and its Control 6.1,6.2,6.3,6.4,6.5,6.6,6.7	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- A) Course Code : 2037572(037)
B) Course Title : Machine Design, Estimation and Costing
C) Pre-requisite Course Code and Title :
D) Rationale :

Design is one of the important aspects of engineering. Fundamental knowledge about basic machine design principles is essential for a student of diploma in mechanical engineering. It is expected from a diploma student to know the basic design and selection procedure of simple machine components which are frequently required in industries. With the background of Applied Mechanics, Strength of Materials, Material Technology and Theory of Machines courses, this course is to develop basic design and selection abilities in the student to give solutions to standard engineering design problems using standard selection procedures and manufacturer's catalogue. He should also be aware of related codes, norms and guidelines. It is also expected from him to perform estimation and costing calculations for simple mechanical engineering-based situations.

E) Course Outcomes:

- CO-1 Explain basic concepts used in design of mechanical components.
CO-2 Perform design for static single and multi-axial loading situations.
CO-3 Recommend suitable power transmission elements i.e. shaft, axle, keys and couplings for different applications.
CO-4 Recommend suitable fasteners for different applications (welded, riveted and threaded joints).
CO-5 Recommend suitable Antifriction Bearings for different applications.
CO-6 Describe basic elements of estimating and costing.
CO-7 Perform estimating and costing calculations for simple mechanical engineering-based situations.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+P/2)
1	Mechanical Engineering	2037572(037)	Machine Design, Estimation and Costing	2	-	1	3

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037572(037)	Machine Design, Estimation and Costing	70	20	30	-	-	120

Note: i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
ii. Separate passing is must for End Semester Exam (Theory) and End Semester Exam(Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Explain basic concepts used in design of mechanical components.

(Approx. Hrs: L+P+T=06)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Explain basic design process with examples. SO1.2 Describe the types and uses of the given standard in design of machine parts. SO1.3 Select a material for the given situation and justify the same.		Unit 1.0 Fundamentals of Machine Components Design 1.1 Basic concepts of design in general. 1.2 Factors to be considered in design of machine components a. Selection of Mechanism b. Material c. Loading and Forces on the elements d. Size, shape and space requirements e. Manufacturing f. Operating requirement g. Reliability and safety aspects h. Inspectability i. Maintenance, cost and aesthetics of the designed product j. Failure criterion 1.3 Codes and Standards in Machine Design 1.4 Engineering Materials a. Properties and applications of common engineering materials. b. Important mechanical properties of materials:	<ul style="list-style-type: none"> • Use of Indian Standard and ISO/ASME Codes of Design • Selection of preferred sizes

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		Elasticity, Plasticity, Hardness, Ductility, Malleability, Brittleness, Resilience Toughness, Creep etc.	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

- Prepare a list of tests and map them with corresponding mechanical properties.
- Interpret test data to find mechanical properties of materials.

b. Mini Project:

- Prepare a list of materials along with their properties and designated codes used in manufacturing of common mechanical components.
- Prepare list of common design norms and standards.
- Identify the material used in any four critical machine components, collect the specification of the materials and justify the selection. (group of 4 students)

c. Other Activities (Specify):

- Perform internet search and find the use of manuals, tables, list of standards, and product catalogues associated with mechanical parts design.
- Find Indian Standard and ASME Codes for Design for various machine elements.

CO-2 Perform design for static single and multi-axial loading situations.

(Approx. Hrs: L+P+T=08)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Calculate induced stresses in the given simple mechanical component. SO2.2 Calculate factor of safety for the given stress condition. SO2.3 Explain the procedure for design under the given static single and multi- axial loading situations.		Unit 2.0 Design for Static Loading 2.1 Types of loads, Types of stresses, strains and strengths. 2.2 Factor of safety and stress concentration factor. 2.3 Design under static single axial loading conditions. 2.4 Theories of failure. 2.5 Design under static Multi-axial loading conditions.	• Use of Machine Design Data Book

SW-2 Suggested Sessional Work (SW):

a. Assignments:

- Prepare flow chart of design procedure for components under static single and multi-axial load situations
- Perform designing simple components under static axial single load situation through at least 5 numerical problems

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- iii Perform designing simple components under static multi-axial load situation through at least 5 numerical problems

b. Mini Project:

- i. Identify machine/equipment components under static single and multi-axial load situations and prepare a list of the same. (Group work)

c. Other Activities (Specify):

- i. Collect information from website related to factor of safety values used in designing of various domestic and industrial components.

CO-3 Recommend suitable power transmission elements i.e. shaft, axle, keys and couplings for different applications.

(Approx. Hrs: L+P+T=09)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Sketch the given shaft, key(s) and coupling(s). SO3.2 Design the given shaft, axle, key and coupling for given application. SO3.3 Select the given shaft, keys and coupling for given application from manufacturer's catalogue/ design handbook with justification.		Unit 3.0 Design of Shaft, Axle, Keys and Couplings 3.1 Types of shafts, Shaft materials, Standard sizes. 3.2 Design of solid and hollow Shaft and Axles under twisting moment (TM), Bending Moment (BM). a. Geometric Layout b. Deflection and Rigidity c. Design procedure of solid and hollow shaft based on strength d. Design procedure of solid and hollow shaft based on stiffness. 3.3 Types of keys, effect of keyway on the strength of shaft, design of rectangular and square sunk key. 3.4 Design of Couplings (Muff coupling and Rigid Protected Flange coupling)	<ul style="list-style-type: none">Flexible Shafts.

SW-3 Suggested Sectional Work (SW):

a. Assignments:

- i. Solve simple design problems of shaft, axle, keys and couplings.
ii. Prepare drawings of various shaft and key geometries and corresponding loading diagram.

b. Mini Project:

- i. Prepare CAD models of shaft, axle, keys and couplings.

c. Other Activities (Specify):

- i. Identify shaft, axle, keys and couplings fitted in a machine/automobile and measure dimensions.
ii. Identify type of loading on a shaft, axle, keys and couplings fitted in a machine/equipment.

CO-4 Recommend suitable fasteners for different applications (welded, riveted and threaded joints).

(Approx. Hrs: L+P+T=09)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Design the given riveted joint for the given situation. SO4.2 Calculate the length of weld for the given application. SO4.3 Design the bolted joint for the given situation. SO4.4 Design the given eccentrically loaded bolted/riveted joint. SO4.5 Recommend the type of fasteners for the given situation based on catalogue with justification.		Unit 4.0 Design of fasteners 4.1 Advantages and disadvantages of riveted joints 4.2 Methods of riveting, types of rivet heads, Rivet material and properties, kinds of riveted joints 4.3 Failure of riveted joints, Design of riveted joints, efficiency of riveted joints (including eccentrically loaded) 4.4 Boiler joints 4.5 Types of welded joints, representation of welds 4.6 Design of welded joints for static loads 4.7 Strength of welded joints at varying loads 4.8 Introduction to threaded joints, types of screw fastening, profile of screw threads, materials for fasteners 4.9 Design of bolted joints in various loading conditions (including eccentrically loaded)	<ul style="list-style-type: none"> • Various types of rivet heads • Types of welds

SW-4 Suggested Sectional Work (SW):

a. Assignments:

- i. Solve simple design problems of riveted, welded, and threaded joints.
- ii. Identify various joints in machines and prepare drawings and corresponding loading diagram.

b. Mini Project:

- i. Prepare CAD models of various joints.

c. Other Activities (Specify):

- i. Collect samples of welding, riveted and threaded joints from scrap and make demonstrative models. (Group work)

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

CO-5 Recommend suitable Antifriction Bearings for different applications.

(Approx. Hrs: L+P+T=08)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Identify the given type of antifriction bearing. SO5.2 Explain the procedure of designing and selection of the given type of antifriction bearing. SO5.3 Select suitable antifriction bearing for given application from manufacturer's catalogue with justification.		Unit 5.0 Antifriction Bearings 5.1 Classification of Bearings – Sliding contact and rolling contact. 5.2 Terminology of Ball and Roller bearings – life load relationship, basic static load rating and basic dynamic load rating. 5.3 Selection of ball bearings using manufacturer's catalogue.	<ul style="list-style-type: none"> Application of Ball Screws.

SW-5 Suggested Sectional Work (SW):

a. Assignments:

- Solve numerical problems related to calculation of Bearing life and dynamic Load carrying capacity of a bearing.
- Write complete procedure of selection of any one type of Antifriction bearing from Manufacturer's catalogue.

b. Mini Project:

- CAD model of Deep Groove Ball bearing and Taper Roller Bearing.
- Prepare a list of machines/equipment/devices where different types of antifriction bearings are used.
- Take a deep groove ball bearing, note down its specification/designation and explain the same.

c. Other Activities (Specify):

- Collect/download at least four different Bearing manufacturer's catalogues.
- Collect three types of scrap/used antifriction bearing and fix them on a board with labels. (Group work)

CO-6 Describe basic elements of estimating and costing.

(Approx. Hrs: L+P+T=07)

Session Outcomes (SOs)	Laboratory Instruction (L)	Class room Instruction (P)	Self Learning (SL)
SO6.1 Describe estimating functions, procedure and constituents. SO6.2 Describe Costing methods and procedure. SO6.3 Identify different		Unit 6- Fundamentals of Estimating and Costing 6.1 Definition and aims of Estimating, Functions of Estimating and role of Estimating department. 6.2 Estimating Procedure and constituents of Estimation.	<ul style="list-style-type: none"> Depreciation and insurance charges.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (L)	Class room Instruction (P)	Self Learning (SL)
direct and indirect costs components associated with the given situation.		6.3 Definition and aims of Costing. 6.4 Difference between Estimating and Costing. 6.5 Procedure of Costing, Costing Methods. 6.6 Advantages of efficient costing 6.7 Elements of Cost- Material, labour, expenses. 6.8 Direct and Indirect cost: Factory expenses, administrative expenses, selling expenses and distribution expenses. 6.9 Components of cost	

SW-6 Suggested Sectional Work (SW):

a. Assignments:

- i. Prepare a flow chart of estimating procedure.
- ii. Find the cost estimate for a repair activity in any laboratory of the institute.

b. Mini Project:

- i. Visit nearby industry or your institute workshop and prepare a report on various direct and indirect cost involved and other expenses.
- ii. Prepare a list of different costs associated with various activities related to Mechanical engineering department of your institute.

c. Other Activities (Specify):

- i. Collect data from www/market survey and prepare list of cost of different raw materials, finished raw materials (standard sections, pipe, rods, flat strips, wires etc.), cutting tools, consumables, electricity charges, water charges, other expenses and overheads.

CO-7 Perform estimating and costing calculations for simple mechanical engineering-based situations.

(Approx. Hrs: L+P+T=09)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO7.1 Estimate the time for the given machining operation SO7.2 Estimate volume and weight of the raw material(s) required for the given situation. SO7.3 Estimate the time required to perform the given welding/ forging/ foundry		Unit-7.0 Estimation and Costing Applications 7.1 Terminology used in machine shop like cutting speed, feed and depth of cut 7.2 Lathe Operations- Turning, Facing, Knurling, Drilling, Boring, Reaming, Threading and Tapping	<ul style="list-style-type: none"> Recall various Milling machine operations, Drilling machine operations, Shaper machine operations, Welding operations, Assembly operations, Casting process, Forming operations.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
work		7.3 Estimation of volume and weight of material 7.4 Use of formula to calculate actual machining time for different machining operations 7.5 Estimation of time related to Welding shop 7.6 Estimation of time related to Forging shop 7.7 Estimation of time related to Pattern making and Foundry shops	

Legend: Cl: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-7 Suggested Sectional Work (SW):

a. Assignments:

- Estimate time required for various activities for anyone machining operation.
- Estimate time required in various activities related to manufacturing of one component in each shop (Machining shop, fitting shop, pattern making shop, carpentry shop, welding shop, foundry shop, forming shop etc.).
- Perform calculations to find material and labour cost related to production of simple shaped components in each shop.

b. Mini Project:

- Visit nearby industry or your institute workshop and prepare a report on various direct and indirect cost involved and other expenses.

c. Other Activities (Specify):

- Prepare report on prevailing labour costs/rates associated with different manufacturing processes/operations.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Fundamentals of Machine components design	2	2	4	08
II	Design for Static Loading	-	2	8	10
III	Design of Shaft, Axle and Keys and Couplings	2	4	6	12
IV	Design of Fasteners	2	4	6	12
V	Anti friction Bearings	2	2	6	10
VI	Fundamentals of Estimating and Costing	2	3	3	08
VII	Estimation and Costing applications	-	2	8	10
Total		10	19	41	70

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*): Not Applicable

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1	A Textbook of Machine Design	P C Sharma and D K Aggarwal	S. K. Kataria & Sons, New Delhi	13e, 2017 ISBN(13) 9789350142813
2	Machine Design	U. C. Jindal	Pearson Education, India, New Delhi	2010, ISBN13: 9788131716595
3	Machine Design Data Book	Kamal Kumar and S K Dhagat	Khanna Publishers, New Delhi	5e, 2009, ISBN(10) 8174091505
4	Machine Design Data Book	V B Bhandari	McGraw Hill Education (India) Pvt. Ltd., New Delhi	2014, ISBN(13): 978- 9351342847
5	Design of Machine Elements	V B Bhandari	McGraw Hill Education (India) Pvt. Ltd., New Delhi	4e, 2016, ISBN(13): 9789339221126

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

6	Design Data Book	PSG	PSG College of Technology Coimbatore	2012, ISBN-10: 8192735508
7	IS Codes: IS 4218: 1967 ISO Metric Threads IS 2693: 1964 Cast Iron Flexible Couplings IS 2292: 1963 Taper keys and Keyways IS 2293: 1963 Gib Head Keys and Keyways IS 2389: 1963 Bolts, Screws, Nuts and Lock Nuts IS 4694: 1968 Square threads IS 808: 1967 Structural Steel SKF/NBC Catalogue for Bearings	ISO	Indian Standard Bureau, New Delhi	
8	Mechanical Estimating and Costing	T.C. Banga and S.C. Sharma	Khanna Publishers, New Delhi	16th edition (2003) ISBN-13: 978- 8174091000

*Latest edition of all above books should be referred

(b) Open source software and website address:

- i. <https://www.pdgonline.com/courses/m236/m236.htm>
- ii. <https://www.mcmaster.com/>
- iii. <http://nptel.ac.in/downloads/112105125/>
- iv. <https://en.wikipedia.org/wiki/Fastener>
- v. <http://nptel.ac.in/courses/112105124/>
- vi. <https://www.youtube.com/watch?v=CLeLFUrvO2g>
- vii. www.machinedesignonline.com
- viii. www.engineeringtoolbox.com
- ix. <https://www.youtube.com/watch?v=N5SckoiTDxA>
- x. <https://www.youtube.com/watch?v=GfbcxJmjn9s>
- xi. <http://www.ignou.ac.in/upload/Unit-5-60>
- xii. https://sizes.com/numbers/preferred_numbers.htm
- xiii. www.robot-and-machines-design.com/en/articles/mech
- xiv. <http://www.youtube.com/flangedcoupling>

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Manufacturers' Catalog
5. Design data book
6. Charts and models of Pulley, shafts, keys, couplings, belt, chain, Anti friction bearings, joints, fasteners.

M) List of Major Laboratory Equipment and Tools: Not Applicable

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
CO-1 Explain basic concepts used in design of mechanical components.	2	3	3	2	2	1	3	2	2	2	-	2	-
CO-2 Perform design for static single and multi-axial loading situations.	2	3	3	2	2	1	3	2	2	2	2	2	-
CO-3 Recommend suitable power transmission elements shaft, axle, keys and couplings for different applications.	2	3	3	2	2	1	3	2	2	2	2	2	-
CO-4 Recommend suitable fasteners for different applications (welded, riveted and threaded joints).	2	3	3	2	2	1	3	2	2	2	2	2	-
CO-5 Recommend suitable Antifriction Bearings for different applications.	2	3	3	2	2	1	3	2	2	2	2	2	-
CO-6 Describe basic elements of estimating and costing.	1	3	2	2	2	1	3	2	2	3	2	-	2
CO-7 Perform estimating and costing calculations for simple mechanical engineering-based situations.	1	3	2	2	2	1	3	2	2	3	2	-	2

Legend: 1 – Low, 2 – Medium, 3 – High

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-2	CO-1 Explain basic concepts used in design of mechanical components.	SO1.1 SO1.2 SO1.3		Unit 1.0 Fundamentals of Machine components design 1.1, 1.2, 1.3, 1.4	As mentioned in relevant page numbers
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-2 Perform design for static single and multi-loading situations.	SO2.1 SO2.2 SO2.3		Unit 2.0 Design for Static Loading 2.1, 2.2, 2.3, 2.4, 2.5	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-3 Recommend suitable power transmission elements shaft, axle, keys and couplings for different applications.	SO3.1 SO3.2 SO3.3		Unit 3.0 Design of Shaft, Axle and Keys and Couplings 3.1, 3.2, 3.3, 3.4	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-4 Recommend suitable fasteners for different applications (welded, riveted and threaded joints).	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4.0 Design of Fasteners 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-5 Recommend suitable Antifriction Bearings for different applications.	SO5.1 SO5.2 SO5.3		Unit-5.0 Anti friction Bearings 5.1, 5.2, 5.3	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,3	CO-6 Describe basic elements of estimating and costing.	SO6.1 SO6.2 SO6.3		Unit-6.0 Fundamentals of Estimating and Costing 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,3	CO-7 Perform estimating and costing calculations for simple mechanical engineering-based situations.	SO7.1 SO7.2 SO7.3		Unit-7.0 Application of Estimation and Costing 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- A) Course Code : 2037573(037)
 B) Course Title : Machine Tool Technology
 C) Pre-requisite Course Code and Title :
 D) Rationale :

Production and manufacturing industries encompasses more than one-third among industrial organizations. Major activities involved in these industries are metal cutting and machining. Basic knowledge of mechanics of machining, metal cutting, types of tools and tool life is the prerequisite for understanding the working of various machine tools and operations performed on them. In this context topics like cutting forces, cutting tools, tool life, machining through Shaper, Planner, Slotter, Drilling, Milling, Broaching machines and grinding and finishing operations, installation and testing of machine tools are included in this course to enable the students to work with and tackle the situation arises day by day while working with machine tools. Knowledge of these aspects will help the student to understand and improve insight into the practical applications.

E) Course Outcomes:

- CO-1 Apply the basics of metal cutting and machine tools in machining processes.
 CO-2 Evaluate the tool life and assess the influence of related parameters over it.
 CO-3 Supervise production of jobs on Shaper, Planner and Drilling machines.
 CO-4 Supervise production of jobs on Milling and Broaching machines.
 CO-5 Supervise grinding and finishing operations.
 CO-6 Perform installation and testing of machine tools.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+(P/2)
1	Mechanical Engineering	2037573(037)	Machine Tool Technology	2	-	1	3
2	Mechanical Engineering	2037562(037)	Machine Tool Technology (Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037573(037)	Machine Tool Technology	70	20	30	-	-	120
2	Mechanical Engineering	2037562(037)	Machine Tool Technology (Lab)	-	-	-	30	50	80

- Note:** i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
 ii. Separate passing is must for End Semester Exam (Theory) and End Semester Exam(Practical).

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Apply the basics of metal cutting and machine tools in machining processes.

(Approx. Hrs: L+P+T=13)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Recognize the type of the given cutting tool and its application. SO1.2 Enlist the desirable properties of the given cutting tool material. SO1.3 Interpret the tool signature and inter relationship between ASA and ORS of the given tool. SO1.4 Explain the influence of the given tool angle(s) on cutting parameters. SO1.5 List the types of chip likely to be formed during machining of the given material(s).	LE1.1 Select appropriate cutting tool for a given machining situation and fix it properly in the tool post accurately. LE1.2 Interpret the given tool signature and observe the change in angles values if the tool is not fitted accurately in the tool post. LE1.3 Perform plain turning operations on Steel, Brass and Aluminum etc. workpieces and observe the formation of type of chip. LE1.4 Practice orthogonal and oblique cutting.	Unit 1.0 Metal cutting 1.1 Cutting Tools – types, requirements, specification & application of different cutting tools, cutting tool materials – high carbon steels, high speed steels, non-ferrous cast alloys, cemented carbides, ceramics, diamond, Cubic Boron Nitride, properties and applications 1.2 Geometry of Single Point Cutting Tool - Tool angle, Tool geometry and influence of tool angles, tool signature, Tool angle specification system, ASA, ORS and inter-relationship. 1.3 Mechanics of Metal Cutting - Theories of metal cutting, Chip formation, types of chips, BUE formation condition and its effect upon surface finish, chip breakers, Orthogonal and Oblique cutting, stress and strain in the chip, velocity relations, power and energy requirement in metal cutting.	<ul style="list-style-type: none"> Advanced cutting tool material and their applications

SW-1 Suggested Sessional Work (SW):

a. Assignments:

- Sketch the given tool signature of a single point cutting tool.
- Compare the conditions that lead to formation of various types of chips.
- Explain the effect of various tool angles on metal cutting.

b. Mini Project:

- Prepare a chart showing the different types of cutting tool materials, their properties and applications.
- Prepare a chart of recommended cutting parameters and single point cutting tools used for turning of Steel, Brass, Aluminum, Copper, Cast Iron and their alloys.
- Visit a nearby industry or your institute's workshop and identify the different type of cutting tools in use.

c. Other Activities (Specify):

- i. Prepare a single point cutting tool by cutting different angles using a blade or paper cutter on a rubber eraser (individual work)
- ii. Collect photographs of all the cutting tools generally used in today's industries with CBN, PCBN, TC inserts (group work with group size of five students each)

CO-2 Evaluate the tool life and assess the influence of related parameters over it.

(Approx. Hrs: L+P+T=13)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Determine the forces developed during machining of the given job on the given cutting tools. SO2.2 Predict the tool life for the given machining conditions. SO2.3 Correlate the term machinability index with the machinability SO2.4 Describe the role of cutting fluids in the given cutting operation.	LE2.1 Determine the cutting forces under various conditions of cutting using dynamometer. LE2.2 Observe the effects of using cutting fluid during a machining operation on the temperature of the tool.	Unit 2.0 Mechanics of machining 2.1 Cutting forces and tool life - Forces acting on the cutting tool and their measurement, Merchant's circle diagram, dynamometer, force and velocity relationship, Tool wear, Factors causing wear, tool life, tool life equation, variables affecting tool life, Cutting parameters - speed, feed, depth of cut and machining time, economical cutting speed. 2.2 Machinability - Concept and evaluation of Machinability, Mechanism of Tool failure, Machinability index, factors affecting machinability. 2.3 Thermal Aspects in Machining - Sources of heat generation in machining and its effects, Temperature Measurement techniques in machining, types of cutting fluids, Functions of cutting fluid, Characteristics of cutting fluid, Application of cutting fluids.	• Measurement of tool wear

SW-2 Suggested Sessional Work (SW):

a. Assignments:

- i. Explain the different types of tool wear with their causes.
- ii. Explain the various cutting variables affecting tool life.
- iii. Solve at least 5 numerical problems using Taylor's tool life equation.
- iv. Explain procedure to measure cutting forces in lathe and Milling operations using dynamometers.

b. Mini Project:

- i. Prepare a chart showing the different types of industrial cutting fluids and their areas of application, merits and limitations.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- ii. Visit a nearby industry or your institute's workshop and identify the different type of cutting fluids in use.
- iii. Prepare a chart showing different types of cutting force measurement devices.
- iv. Visit any industry and estimate tool wear for any mass-produced component.

c. Other Activities (Specify):

- i. Measure cutting force with a fresh cutting tool and worn out tool.

CO-3 Supervise production of jobs on Shaper, Planner and Drilling machines.

(Approx. Hrs: L+P+T=18)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Differentiate shaper and planner on constructional aspects. SO3.2 Differentiate counter boring, counter sinking, spot facing. SO3.3 Explain the procedures of producing the given jobs on the given Shaper, Planner and Slotting machine. SO3.4 Select suitable shaping operation parameters and cutting tool for the given job/application with justification.	LE3.1 Machine a flat surface using Shaper. LE3.2 Prepare a square and v – groove using Shaper. LE3.3 Prepare a dove-tail guideway using Shaper. LE3.4 Perform slot cutting operation using Slotter. LE3.5 Perform drilling, reaming, tapping and countersinking operations as per given drawing using a Radial drilling machine LE3.6 Perform boring operation on lathe machine.	Unit 3.0 Shaper, Planner and Drilling machine 3.1 Shaper: Principle of operation, classification, specification, Basic parts and their functions and Applications, safety precautions. 3.2 Slotter: Principle of working, classification, specification. Basic parts of Slotting machine and their functions and Applications, safety precautions. 3.3 Planer: Principle of operation, Classification, Basic parts and their functions, Specifications and Applications, safety precautions. 3.4 Drilling, Reaming & Boring: Drilling: Principle of operation, Classification, Basic parts and functions, drill nomenclature, other operations like counter boring, counter sinking, spot facing etc. Reaming: Principle of operation, description of reamers, and types of reaming operations, safety precautions, Boring: Principle of operation, Classification of boring machines, Basic parts and functions, boring operations, boring tools and applications, safety precautions.	<ul style="list-style-type: none"> Setting of shaper and planner length of stroke.

SW-3 Suggested Sectional Work (SW):

a. Assignments:

- i. Write the specifications of shaper, slotter and planner available in your institute workshop.
- ii. Differentiate between drilling, boring and reaming operations.

- iii. Compare counter boring and counter sinking operations.
- iv. Explain the procedure of producing a Dove-Tail Guideway using a shaper machine.

b. Mini Project:

- i. Prepare a model to demonstrate the working of quick return mechanism of shaper machine.
- ii. Collect information of recent advancements in manufacturing processes, machines/tools/equipment and their specifications/manufacturer and application in the industries.
- iii. Adjust stroke length of quick return mechanism of shaping machine. Record time required for various stroke lengths.
- iv. Prepare a chart of recommended cutting parameters and cutting tools used for Shaping, Planning and slotting of Steel, Brass, Aluminum, Copper, Cast Iron and their alloys.

c. Other Activities (Specify):

- i. Collect videos of manufacturing of different components which involve Shaping, Planning and Slotting operations.
- ii. Collect/download at least four different machine tool manufacturer's catalogues and at least one catalogue each of cutting tool, work holding device and tool holder related to Shaping machine.

CO-4 Supervise production of jobs on Milling and Broaching machines.

(Approx. Hrs: L+P+T=14)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Explain the working of the given milling machine. SO4.2 Select suitable milling operation, parameters and cutter for the given job/application. SO4.3 Use dividing head for the given type of gear cutting. SO4.4 Explain the principle of the given broaching operation.	LE4.1 Make two jobs on milling machine which includes plain milling, slotting using end mill cutter or slitting saw, or side and face milling cutters. LE4.2 Prepare a spur gear using Universal milling machine.	Unit 4.0 Milling and Broaching operations 4.1 Milling: Principle of operation, Classification of milling machines, Basic parts and their functions, Specifications 4.2 Milling cutters – Different types of cutters used in milling, face milling cutter, end milling cutter, Staggered tooth milling cutter, side and face milling cutter, form milling cutters, metal slitting saw etc. 4.3 Milling operations – Plain milling, face milling, side milling, end milling, straddle milling, gang milling, slotting, slitting, Up milling and down milling, safety precautions. 4.4 Dividing head – types, function of dividing head, method of indexing, index plates. 4.5 Broaching: Principle of operation, types of broaches- horizontal, vertical, pull, surface-internal and external broaching machines, Basic	<ul style="list-style-type: none"> • Gear Hobbing Production of Helical Gears

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		parts and their function, nomenclature of broach.	

SW-4 Suggested Sectional Work (SW):

a. Assignments:

- Compare the different milling operations.
- Draw the labeled geometry of a milling cutter and broach tool.
- Solve at least 5 numerical problems on indexing.
- Compare different broaching operations.

b. Mini Project:

- Compare dimensions of a gear tooth of the Gear produced in LE4.2 with the standard gear available in the market/manufacturer catalogue.
- Prepare a list of industrial components which are produced through Milling machining operations and describe the manufacturing procedure of the same in brief.

c. Other Activities (Specify):

- Collect videos of manufacturing of different components which involve Milling and Broaching operations.
- Collect/download at least four different machine tool manufacturer's catalogues and at least one catalogue each of cutting tool, work holding device and tool holder related to Milling machine.

CO-5 Supervise grinding and finishing operations.

(Approx. Hrs: L+P+T=11)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>SO5.1 Explain the principle of grinding and finishing processes.</p> <p>SO5.2 Select suitable type of grinding wheel for the given situation.</p> <p>SO5.3 Select suitable finishing processes for the given job.</p>	<p>LE5.1 Perform an external and internal grinding on a given job.</p> <p>LE5.2 Prepare at least 2 jobs using surface grinder/cylindrical grinder.</p> <p>LE5.3 Perform grinding of a given single point cutting tool.</p>	<p>Unit 5.0 Grinding and Finishing Processes</p> <p>5.1 Grinder and types of grinding wheel, Types of abrasive materials and their properties, Bonding materials, Grinding wheel classification, condition for selection of grinding wheels, balancing of grinding wheels, glazing, loading dressing and Truing. Designation of grinding wheel</p> <p>5.2 Principles of working of grinding machines and functions of main parts, types of grinding processes, function of tool and work holding devices, Table drive in surface and cylindrical grinders, Types of lubricants and coolants</p>	<p>• Surface finish value of component after various super finishing operations</p>

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		used in Grinding, Grinding defects, their remedy and safety practices 5.3 Finishing Processes Definition of micro finishing, honing, lapping, super finishing, polishing and buffing operations, equipment involved, materials used, Tolerances obtained and limitations and applications.	

SW-5 Suggested Sectional Work (SW):

a. Assignments:

- Explain the process of center less grinding with suitable practical example.
- Explain the different symbol and designation used for grinding wheels.
- Write the best safety practices adopted during grinding and finishing process.

b. Mini Project:

- Collect the samples of grinding wheel of different grades.
- Make a comparative study of finishing processes e.g. honing, lapping, super and super finishing operations based on tolerances obtained, limitations and applications.

c. Other Activities (Specify):

- Collect/download at least four different machine tool manufacturer's catalogues and at least one catalogue of grinding wheels related to Grinding machine.
- Prepare list of 10 industrial/domestic items/components on which superfinishing operations are required.

CO-6 Perform installation and testing of machine tools.

(Approx. Hrs: L+P+T=11)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (P)	Self Learning (SL)
SO6.1 Recognize the importance of proper installation of machines. SO6.2 Explain procedure of installation of the given machine tool. SO6.3 Perform suitable acceptance test for the given installed lathe.	LE6.1 Carry out the installation of a given machine. LE6.2 Perform following acceptance tests for a lathe machine available in Institute's workshop: i. Leveling ii. True running of main spindle iii. Axial Slip of main spindle iv. Parallelism of main spindle	Unit 6- Installation and Testing of Machine Tools Foundations, leveling and alignment, Factors affecting the working accuracy of machine tools, Acceptance tests for lathe, Test Charts.	<ul style="list-style-type: none"> Acceptance tests for Milling and Drilling machines. Installation of CNC machines, Non-conventional Machines.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

SW-6 Suggested Sectional Work (SW):

a. Assignments:

- Explain the importance of foundation of a machine tool.
- Write down the foundation procedure used for installing any machine.

b. Mini Project:

- Prepare a report on different acceptance tests conducted on lathe machine.
- Collect test charts for different machine tools e.g. lathe, milling machine, drilling machine etc.

c. Other Activities (Specify):

- Visit nearby industry or your institute workshop and write a report on traditional and modern way of installation of conventional (Lathe, Milling machine, Shaper, Planer, Grinding wheel, Power Hack saw) and non-conventional machine tools (CNC Lathe, CNC Milling, EDM, Abrasive Jet Machine etc.).

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Metal cutting	2	2	6	10
II	Mechanics of machining	2	2	6	10
III	Shaper, Planer and Drilling machine	2	3	10	15
IV	Milling and Broaching operations	2	3	10	15
V	Grinding and Finishing Processes	2	2	6	10
VI	Installation and Testing of Machine Tools	-	4	6	10
Total		10	16	44	70

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)			
		Performance		Viva-Voce	
		PRA	PDA		
LE1.1	Select appropriate cutting tool for a given machining situation and fix it properly in the tool post accurately	15	10	5	30 Marks are allocated for performance under ESE based on following performance parameters: • Preparation of experimental set up • Setting and operation • Safety measures
LE1.2	Interpret the given tool signature and observe the change in angles values if the tool is not fitted accurately in the tool post.	15	10	5	
LE1.3	Perform plain turning operations on Steel, Brass and Aluminum workpieces and observe the formation of type of chip	15	10	5	
LE1.4	Practice orthogonal and oblique cutting.	15	10	5	
LE2.1	Determine the cutting forces under various conditions of cutting using dynamometer.	15	10	5	
LE2.2	Observe the effects of using cutting fluid during a machining operation on the temperature of the tool.	15	10	5	
LE3.1	Machine a flat surface using Shaper.	15	10	5	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)			
		Performance		Viva-Voce	
		PRA	PDA		
LE3.2	Prepare a square and v – groove using Shaper	15	10	5	<ul style="list-style-type: none">• Observations and Recording• Interpretation of result and conclusion• Answer to sample questions Submission of report/sheets in time
LE3.3	Prepare a dove-tail guideway using Shaper.	15	10	5	
LE3.4	Perform slot cutting operation using Slotter.	15	10	5	
LE3.5	Perform drilling, reaming, tapping and countersinking operation as per given drawing using a Radial drilling machine	15	10	5	
LE3.6	To perform boring operation on lathe machine.	15	10	5	
LE4.1	Make two jobs on milling machine which includes plain milling, slotting by using end mill cutter or slitting saw, or side and face milling cutter.	15	10	5	
LE4.2	Prepare a spur gear using Universal milling machine.	15	10	5	
LE5.1	Perform an external and internal grinding on a given job	15	10	5	
LE5.2	Prepare at least 2 jobs using surface grinder/cylindrical grinder.	15	10	5	
LE5.3	Perform grinding of a given single point cutting tool.	15	10	5	
LE6.1	Carry out the installation of a given machine.	15	10	5	
LE6.2	Perform following acceptance tests for a lathe machine available in Institute’s workshop: i. Leveling ii. True running of main spindle iii. Axial Slip of main spindle iv. Parallelism of main spindle	15	10	5	

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30 Marks** as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1	Machine tool engineering	G.R. Nagpal	Khanna Publishers	ISBN 13: 8174090460
2	Production Engineering	P. C. Sharma	S.chand, New Delhi.	ISBN 10: 8121901111
3	Manufacturing technology vol.II	P.N. Rao	Mcgraw hill Pub.	ISBN-10: 1259029565
4	Manufacturing process	O.P. Khanna	Dhanpat Rai Publication	ISBN: 9788189928 230
5	Production Technology	R.K Jain	Khanna Publishers	ISBN-10: 8174090991
6	Workshop Technology Vol 1 & 2	Hajra Choudhary	Media Promoters and Publishers Ltd	ISBN: 9788185099 149 &
7	Manufacturing Processes Vol I and II	H.S. Bawa	McGraw Hill, New Delhi	ISBN - 0070583722

*Latest edition of all above books should be referred

(b) Open source software and website address:

- i. NPTEL Courses- <http://nptel.ac.in/courses/112105126/>
- ii. Metal cutting- https://www.youtube.com/results?search_query=Metal+cutting
- iii. https://www.youtube.com/results?search_query=Cutting+forces+and+tool+life
- iv. https://www.youtube.com/results?search_query=Machinability+
- v. https://www.youtube.com/results?search_query=Shaper%2C+planner+and+drilling+operation
- vi. https://www.youtube.com/results?search_query=Milling+operations+
- vii. https://www.youtube.com/results?search_query=Grinding+and+Finishing+Processes
- viii. https://www.youtube.com/results?search_query=Installation+and+Testing+of+Machine+Tools

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Manufacturers' Catalog
5. Lab Manuals

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Different Single point and multi point cutting tools	Single point cutting tool with various inserts like WC Coated Carbide, CBN, PCBN Milling Cutter, Drill Bits, Reamers, Taps, Shaper tool, Grinding wheels	LE1.1-1.4
2	Center Lathe	Center Lathe Machine (Length between centers: 2000 mm)	LE1.4
3	Lathe tool dynamometer	Forces in X - Y - Z directions will be shown individually Capacity: X, Y, Z - Force 500 Kg Dynamometer Mounting hole-25 mm dia Hole to mount sensor on tool post. Excitation: 10v Dc Linearity: 2% Accuracy: 2% Cross-Sensitivity: 5% Max. Overload: 150 %	LE2.1
4	Milling tool dynamometer	Forces in X - Y - Z directions will be shown individually Capacity: X, Y, Z - Force 500 Kg Job Mounting holes M10 provided to fix machine vise. Mounting Type-350(L) x 350(W) x 100(H)mm. Dynamometer Mounting hole-25 mm dia Hole to mount sensor on tool post. Excitation: 10v Dc Linearity: 2% Accuracy: 2% Cross-Sensitivity: 5% Max. Over Load : 150 %	LE2.1
5	Drill tool dynamometer	Capacity- 500Kg Thrust load, 20 Kgm-torque. Mounting- Flang type to mount on the machine bed. Sensor Type- Straingauge based 350Ω bridge. Job Mounting- Slots provided on the flange plate to mount the machine vise. Excitation: 10v Dc Linearity: 2% Accuracy: 2% Cross-Sensitivity: 5% Max. Over Load : 150 %	LE2.1
6	Thermometer	Infrared thermometer Temperature range : - 30°C to 500°C D/S ratio – 10:1 IP40 dust & water resistant	LE-2.2
7	Shaper with required set of work holding devices, cutting tools, accessories and tool holders.	Length of stroke: Max.500 mm No. of Ram cycles / min.: Max.140 strokes/min. Motor Power: A.C. 7.5 H.P.	LE3.1, LE3.2, LE3.3
8	Slot cutter machine	Fully Automatic Slot Cutting SPM (cutting chuck nuts in this example) part material- Mild Steel, Carbide Side & Face cutter,	LE3.4

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
		slot- 6.5mm x 3.2mm part width- 6.5mm, qty- 14 pcs, indexing- 6 (adjustable to 3, 4, 6, 8, 12, 24) machining cycle time- 1 min 30 secs	
9	Drilling machine with required set of work holding devices, cutting tools, accessories and tool holders.	Drilling Capacity: 40 mm Column Diameter: 75 mm Spindle Hole Taper: MT-2 Spindle Speeds: 50–3000 RPM Spindle Nos. To table Dist.: 605 mm Spindle Center To Pillar: 206 mm Table Size: 260 mm Motor: 0.5 HP	LE3.5
10	Boring tool attachment for lathe	5/8" Right-Hand Boring Bar & Threading Kit, Boring Bar 5/8" (Right-Hand), TiN-Coated Indexable Insert, Threading Insert, Replacement Screw for 5/8" Boring Bar. Boring Bar 9-Piece Set, Boring Head	LE3.6
11	Milling machine with required set of work holding devices, cutting tools, accessories and tool holders.	Face of Body-12" Surface of Table-12"x54" size of tee slots No-1/2"=3 Cross-12 Vertical Traverse-24" Longitudinal automatic-30" Table Rotation side to side-45"-0-45" Standard Arbour-1" Taper of Spindle-ISO-40 No. of Spindle Speed-9 Range of Spindle speed RPM-45 TO 1000 No. of Feed Longitudinal-3.S.F.M Motor H.P & R.P.M: 3 H.P/1440 RPM	LE4.1, LE4.2
12	Grinding machine	Working Surface of the table- 225 x 450mm Maximum Height from Table to Grinding Wheel- 275mm Vertical Feed Least Count- 0.01mm Micro Feed Least Count- 0.002mm Spindle Speed- 2800 RPM Electric Motor recommended- 1 HP - 2800 RPM	LE5.1, LE5.2
13	Tool and Cutter grinder	Longitudinal travel of table: 230mm Cross travel of saddle: 180mm Vertical adjustment of wheel head: 120mm Rotary angle of wheel head: 360° Rotary angle of up-down spindle: 360° Working table area: 620 x 190mm Size of wheel: 180 x 25 x 31.75mm 125 x 50 x 31.75mm Speed of wheel: 3,600 RPM Motor: 3/4 HP, 110V / 220V / 380V	LE5.3
14	Equipment and chart for Acceptance test of machine	Equipment and chart for Acceptance test of machine tools, Dial Gauges, Sprit Levels, Test Mandrels, Straight	LE6.1, LE6.2

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
	tools	edges. True running of the spindle, Perpendicularity/ Parallelism between spindle and base plate, Perpendicularity between the feed movement and the baseplate/guideways,	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
CO-1 Apply the basics of metal cutting and machine tools in machining processes.	2	3	3	2	1	1	2	2	1	2	-	2	2
CO-2 Evaluate the tool life and assess the influence of related parameters over it.	2	3	3	2	1	1	1	2	1	2	-	2	2
CO-3 Supervise production of jobs on Shaper, Planner and Drilling machines.	2	3	3	2	2	1	2	2	2	2	-	2	3
CO-4 Supervise production of jobs on Milling and Broaching machines.	2	3	3	2	2	1	2	2	2	2	-	2	3
CO-5 Supervise grinding and finishing operations.	2	3	3	2	2	1	2	2	2	2	-	2	3
CO-6 Perform installation and testing of machine tools.	1	3	3	2	2	1	3	2	2	2	-	2	1

Legend: 1 – Low, 2 – Medium, 3 – High

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-2,3	CO-1 Apply the basics of metal cutting and machine tools in machining processes.	SO1.1- SO1.5	LE1.1 LE1.2 LE1.3 LE1.4	Unit 1.0 Metal cutting 1.1, 1.2, 1.3	As mentioned in relevant page numbers
PO-1,2,3,4,5,6, 7,8,9,10 PSO-2,3	CO-2 Evaluate the tool life and assess the influence of related parameters over it.	SO2.1-SO2.4	LE2.1 LE2.2	Unit 2.0 Mechanics of machining 2.1, 2.2, 2.3	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-2,3	CO-3 Supervise production of jobs on Shaper, Planner and Drilling machines.	SO3.1 SO3.2 SO3.3 SO3.4	LE3.1 -LE3.6	Unit 3.0 Shaper, planner and drilling machine 3.1, 3.2, 3.3, 3.4	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-2,3	CO-4 Supervise production of jobs on Milling and Broaching machines.	SO4.1 SO4.2 SO4.3 SO4.4	LE4.1 LE4.2	Unit-4.0 Milling and Broaching operations 4.1, 4.2, 4.3, 4.4, 4.5	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-2,3	CO-5 Supervise grinding and finishing operations.	SO5.1 SO5.2 SO5.3	LE5.1 LE5.2 LE5.3	Unit-5.0 Grinding and Finishing Processes 5.1, 5.2 ,5.3	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-2,3	CO-6 Perform installation and testing of machine tools.	SO6.1 SO6.2 SO6.3	LE6.1 LE6.2	Unit-6.0 Installation and Testing of Machine Tools	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

A) Course Code : 2037575(037)

B) Course Title : Fluid Power Engineering

C) Pre-requisite Course Code and Title :

D) Rationale :

Fluid power systems, consisting of oil hydraulic systems and pneumatic systems are widely used in machines and equipment due to its versatility and adaptability to automation. Diploma engineers come across such systems in all the segments of industries and are responsible for operation and maintenance of these. This course will equip the students with the skills and knowledge required for operation and maintenance of hydraulic and pneumatic systems in the field.

E) Course Outcomes:

CO-1 Apply the basic concepts of fluid flow to Fluid Power Systems.

CO-2 Explain the operation of various components of hydraulic systems.

CO-3 Select components required for making hydraulic circuits for simple applications.

CO-4 Explain the operation of various components of pneumatic systems.

CO-5 Select components required for making pneumatic circuits for simple applications.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+(P/2)
1	Mechanical Engineering	2037575(037)	Fluid Power Engineering	2	-	1	3
2	Mechanical Engineering	2037564(037)	Fluid Power Engineering (Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037575(037)	Fluid Power Engineering	70	20	30	-	-	120
2	Mechanical Engineering	2037564(037)	Fluid Power Engineering (Lab)	-	-	-	30	50	80

Note: i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
ii. Separate passing is must for End Semester Exam(Theory) and End Semester Exam(Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Apply the basic concepts of fluid flow to Fluid Power Systems.

(Approx. Hrs: L+P+T=14)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Describe various concepts governing fluid flow. SO1.2 Compare fluid power transmission with electrical and mechanical power transmission SO1.3 Identify the basic components and symbols of a hydraulic and pneumatic system. SO1.4 List the basic properties of oils used as hydraulic fluid.	LE1.1 Identify the components of hydraulic and pneumatic systems on Hydraulic and Pneumatic Trainer. LE1.2 Draw the symbols used in hydraulic and pneumatic circuits.	Unit 1.0 Introduction to Fluid Power Systems 1.1 Power transmission modes and their comparison, Concept of Fluid Power, Transmission of forces in fluid – Pascal's law, multiplication of forces, Factors affecting the fluid flow – gravity, atmospheric pressure, applied forces, inertia & friction, Application and advantages of fluid power. 1.2 Basic components of a fluid power system – Reservoir or Receiver, Pump or compressor, Piping, tubing or hose, Directional control valve and Actuating device. ISO Symbols used in Hydraulic & Pneumatic system. 1.3 Oil, Hydraulic & Pneumatic systems: General layout, symbols used, Applications, Merits, Limitations. 1.4 Hydraulic Fluids-Functions and properties, Types, ISO and SAE grades of oils, Selection of hydraulic fluids.	<ul style="list-style-type: none"> Recall Fluid types and their properties. Industrial Applications of fluid power systems especially in the field of automation.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

- i. Explain how the forces are transmitted in a fluid.
- ii. List the functions of basic components of a fluid power system.
- iii. List at least 5 industrial applications each of hydraulic and pneumatic systems.
- iv. Explain in brief the desirable properties of a hydraulic fluid.
- v. List the factors that affect the selection of hydraulic fluid for a given application.

b. Mini Project:

- i. Prepare/Download a power point presentation/dynamic animation on working of hydraulic /pneumatic brakes/power steering used in automobiles.
- ii. Prepare/Download a power point presentation/dynamic animation on working of hydraulic jack.

c. Other Activities (Specify):

- i. Collect photographs of different hydraulic and pneumatic systems used in real life situations. (group work with group size of five students each)

CO-2 Explain the operation of various components of hydraulic systems.

(Approx. Hrs: L+P+T=15)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Explain working of the given pump. SO2.2 Compare different types of pumps. SO2.3 Explain working of the given actuator. SO2.4 Explain working and method of actuation of the given hydraulic control valve. SO2.5 Select appropriate Pump, Actuator and Valve for the given hydraulic application with Justification. SO2.6 Use various hydraulic accessories with its location on hydraulic system.	LE2.1 Operate various types of Pumps, Control valves and Actuators under different settings required for a Hydraulic circuit.	Unit 2.0 Elements of Hydraulic Systems 2.1 Pumps: Classification of pumps, Comparison of positive (Hydrodynamic) & non-positive displacement (Hydrostatic) pumps, Construction and working of Gear , vane, Screw, piston pumps(axial and radial), Performance characteristics and Selection of pumps 2.2 Actuators: Classification of actuators, Construction and working of hydraulic actuators, Linear and rotary actuators (Motors) used for hydraulic applications. 2.3 Control Valves for hydraulic system: Classification- Direction control valves- Check valve, 2/2,3/2,4/2,4/3,5/2,5/3, D.C. Valves used in Hydraulics, Standard centre positions, Methods of actuation, Pressure control valves- relief, unloading, sequence, counterbalance, pressure reducing valves 2.4 Flow control valves- Non compensated, Pressure and temperature compensated 2.5 Seals, Filters, Pipes, Hoses, Reservoirs, 2.6 Accumulators and Pressure intensifiers.	<ul style="list-style-type: none"> • Sources of contamination in hydraulic systems and their control. • Remote operation of valves.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

- i. List the functions of Hydraulic control valves.
- ii. Differentiate between positive and non-positive displacement pumps.
- iii. Compare the pumps on the basis of following parameters:
(a) Pressure rating (b) Speed rating (c) Flow capacity (d) Overall efficiency (e) Cost
- iv. Differentiate between single and double acting cylinder.
- v. List the functions of accumulators and pressure intensifiers.
- vi. State the function of filter in Hydraulic circuit. Describe proportional flow filter with a neat sketch.

b. Mini Project:

- i. Collect technical specifications of different types of pumps used in hydraulic systems.

c. Other Activities (Specify):

- i. Give a seminar on different types of hydraulic control valves.

CO-3 Select components required for making hydraulic circuits for simple applications.

(Approx. Hrs: L+P+T=18)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.1 Draw labeled sketch of various oil hydraulic circuits. SO3.2 Describe the working of the given oil hydraulic circuit. SO3.3 Select appropriate components required for the given hydraulic circuit. SO3.4 Develop hydraulic circuit for the given application using selected components SO3.5 Perform trouble shooting in the given hydraulic system.	LE3.1 Prepare hydraulic circuit for an application using hydraulic simulation software and simulate its working. LE3.2 Create hydraulic circuit to actuate single acting cylinder. LE3.3 Create hydraulic circuit to actuate double acting cylinder. LE3.4 Create hydraulic circuit to control the speed of hydraulic motor. LE3.5 Create meter-in and meter-out circuits. LE3.6 Create a sequential hydraulic circuit. LE3.7 Trouble shoots of the given Hydraulic circuits.	Unit 3.0 Oil Hydraulic Circuits 3.1 Control of single and Double acting Hydraulic cylinders. 3.2 Speed control double acting cylinder - Meter-in, Meter-out, Bleed Off circuit. 3.3 Unloading circuits, Regenerative circuits, Counterbalance valve & circuit, speed control of bidirectional hydraulic motor, braking and replenishing of hydraulic motor, synchronizing circuits, Sequencing Circuits. 3.4 Applications, ISO Symbols used in hydraulic circuits. 3.5 Hydraulic circuits for Milling machine and Shaper machine. 3.6 Common troubles in hydraulic systems, their causes and remedies.	<ul style="list-style-type: none"> Industrial Applications of hydraulic circuits.

SW-3 Suggested Sectional Work (SW):

a. Assignments:

- i. Describe how speed of cutting stroke of shaper machine is regulated with neat labeled sketch.

- ii. Compare meter in and meter out circuits.
- iii. Explain with neat sketch the working of hydraulic circuit for milling machine.
- iv. Draw labeled sequencing circuit and describe its operation.

b. Mini Project:

- i. Observe and prepare a detailed report of hydraulic system used in at least one machine available in your institute's workshop/laboratories.
- ii. Prepare a detailed report on common troubles occurring in hydraulic circuits, their causes and remedies.

c. Other Activities (Specify):

- i. Collect videos of hydraulic circuit and try them on hydraulic trainer available in your lab.

CO-4 Explain the operation of various components of pneumatic systems.

(Approx. Hrs: L+P+T=15)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>SO4.1 Explain the construction & working of the given compressor used in pneumatic systems.</p> <p>SO4.2 Explain the working of given device(s) used for air treatment of compressed air.</p> <p>SO4.3 Explain working of the given pneumatic actuator.</p> <p>SO4.4 Explain working of the given pneumatic control valves.</p> <p>SO4.5 Select appropriate compressor, actuator and control valve for the given pneumatic application with justification.</p> <p>SO4.6 Select various accessories with their location for the given pneumatic system.</p>	<p>LE4.1 Operate different compressors and actuators mounted on the given pneumatic trainer under different setting required for a pneumatic circuit.</p> <p>LE4.2 Operate FRL unit and control valves mounted on the given pneumatic trainer under different setting.</p>	<p>Unit 4.0 Elements of Pneumatic Systems</p> <p>4.1 Air Compressors –Recall Types, construction & working of Reciprocating & Rotary compressors, Selection of compressor.</p> <p>4.2 Air treatment-Air receiver, Moisture separator and Air dryer, FRL unit, Pressure regulator.</p> <p>4.3 Pneumatic actuators: Pneumatic Cylinders - Single & double acting cylinders, Air Motors – Vane, Georotor, Turbine and Piston motor. Electrical actuators for pneumatic systems, comparison between Air, Hydraulic and Electric actuators.</p> <p>4.4 Pneumatic control valves: Classification-Direction control valves - 2/2,3/2,4/2,4/3,5/2,5/3, Pressure control valves- relief, unloading, sequence, counterbalance, pressure reducing valves, Flow control valves- Non compensated, Pressure and temperature compensated, Dual (twin)pressure valve, Shuttle valve, Quick exhaust valve, Time delay valve.</p> <p>4.5 Accessories: Pipes, hoses, fittings, Seals and gaskets, Accumulators, heat exchanger, muffler.</p>	<ul style="list-style-type: none"> • Mixture of gases – Dalton's law of partial pressure.

SW-4 Suggested Sectional Work (SW):

a. Assignments:

- i. Explain the need of air treatment of compressed air.
- ii. List the various components of pneumatic circuit and give its application.
- iii. Classify pneumatic actuators on the basis of i) Motion ii) Mode of action iii) Displacement and describe telescopic cylinder with sketch.
- iv. Differentiate between Hydraulic and Pneumatic circuit with respect to the following parameters:
(a) Medium (b) Pressure (c) Application and (d) Lubrication.
- v. Describe with neat sketch construction and working of pneumatic hose.
- vi. State the function of each component of FRL unit.
- vii. List the factors to be considered for selection of pipes for pneumatic applications.

b. Mini Project:

- i. Visit an automobile service station and prepare a report on use of pneumatic hand tools.
- ii. Observe and prepare a report on hydraulic/pneumatic circuits in commonly used machines at construction sites like JCB/Pneumatic breaker/Spray gun etc.

c. Other Activities (Specify):

- i. Collect videos of various pneumatic components and their working.

CO-5 Select components required for making pneumatic circuits for simple applications.

(Approx. Hrs: L+P+T=18)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Explain the working and constructional details of the given CNC milling machine. SO5.2 Draw labeled sketch of various pneumatic circuits. SO5.3 Describe the working of the given pneumatic circuits. SO5.4 Select appropriate components required for the given pneumatic circuit. SO5.5 Develop pneumatic circuit for the given application using selected components SO5.6 Perform trouble shooting in the given pneumatic system.	LE5.1 Prepare pneumatic circuit for an application using pneumatic simulation software and simulate its working. LE5.2 Create pneumatic circuit to actuate single acting cylinder. LE5.3 Create pneumatic circuit to actuate double acting cylinder. LE5.4 Create pneumatic circuit to control the speed of motor. LE5.5 Create a sequential pneumatic circuit. LE5.6 Troubleshoots of the given pneumatic circuits.	Unit 5.0 Pneumatic Circuits 5.1 Direct/Indirect Control of single and Double acting Air cylinders. 5.2 Actuation of Pneumatic motor (Air Motor) 5.3 Speed control of double acting cylinder and Bi-directional Air motor. 5.4 Sequencing circuits. 5.5 Time delay operation. 5.6 Hydro-pneumatic applications Air-Oil reservoir, Air-Oil cylinder, Air-Oil Intensifier. 5.7 Pneumatic sensors. 5.8 Common troubles in pneumatic systems, their causes and remedies.	<ul style="list-style-type: none"> Industrial Applications of pneumatic systems.

SW-5 Suggested Sectional Work (SW):

a. Assignments:

- i. Explain with a neat sketch the sequencing circuit for double acting air cylinder.
- ii. Explain pneumatic circuit for speed control of single acting cylinder.
- iii. Explain the speed control of bidirectional air motor with a neat and labeled sketch.

b. Mini Project:

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- i. Prepare a detailed report on the working of pneumatic drilling rigs used for water bores.
 - ii. Prepare a detailed report on common troubles occurring in pneumatic circuits, their causes and remedies.
- c. **Other Activities (Specify):**
- i. Collect videos of pneumatic circuit and try them on hydraulic trainer available in your lab.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Introduction to Fluid Power Systems	4	6	-	10
II	Elements of Hydraulic Systems	4	4	6	14
III	Oil Hydraulic Circuits	-	4	12	16
IV	Elements of Pneumatic Systems	4	4	6	14
V	Pneumatic Circuits	-	4	12	16
Total		12	22	36	70

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Identify the components of hydraulic and pneumatic systems on Hydraulic and Pneumatic Trainer.	15	10	5
LE1.2	Draw the symbols used in hydraulic and pneumatic circuits.	15	10	5
LE2.1	Operate various types of Pumps, Control valves and Actuators under different settings required for a Hydraulic circuit.	15	10	5
LE3.1	Prepare hydraulic circuit for an application using hydraulic simulation software and simulate its working.	15	10	5
LE3.2	Create hydraulic circuit to actuate single acting cylinder.	15	10	5
LE3.3	Create hydraulic circuit to actuate double acting cylinder.	15	10	5
LE3.4	Create hydraulic circuit to control the speed of hydraulic motor	15	10	5
LE3.5	Create meter-in and meter-out circuits.	15	10	5
LE3.6	Create a sequential hydraulic circuit.	15	10	5
LE3.7	Trouble shoots of the given Hydraulic circuits.	15	10	5
LE4.1	Operate different compressors and actuators mounted on the given pneumatic trainer under different setting required for a pneumatic circuit.	15	10	5
LE4.2	Operate FRL unit and control valves mounted on the given pneumatic trainer under different setting.	15	10	5
LE5.1	Prepare pneumatic circuit for an application using pneumatic simulation software and simulate its working.	15	10	5
LE5.2	Create pneumatic circuit to actuate single acting	15	10	5

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	cylinder.			
LE5.3	Create pneumatic circuit to actuate double acting cylinder.	15	10	5
LE5.4	Create pneumatic circuit to control the speed of motor.	15	10	5
LE5.5	Create a sequential pneumatic circuit.	15	10	5
LE5.6	Trouble shoots the given pneumatic circuits.	15	10	5

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30** Marks as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Introduction to Hydraulics and Pneumatics	Ilango Sivaraman	PHI	ISBN-13: 978-8120344068
2.	Hydraulics and Pneumatics	T Jagdeesha	I K Publishing Company	ISBN 13: 9789384588908
3.	Hydraulics and Pneumatics	S Sameer, K Ilyias	R K Publications	ISBN13: 978-9352689057
4.	Hydraulics and Pneumatics	Andrew Parr	Jaico Publishing House	ISBN13: 978-8172241896
5.	Hydraulics and Pneumatic Controls	Sundaram K Shanmuga	S Chand	ISBN13: 978-8121926355
6.	Fluid Power with applications	Esposito	Pearson Education India	ISBN13- 978-9332518544
7.	Industrial Fluid Power	C P Murgudkar	Nirali Prakashan	ISBN-13: 978-0960564453

(b) Open source software and website address:

- i. <http://www.nptel.ac.in>
- ii. Hydarulic Pumps: https://en.wikipedia.org/wiki/Hydraulic_pump
- iii. Hydraulic Pumps: www.hydraulicspneumatics.com/.../HydraulicPumpsM/.../TechZone-HydraulicPumps.
- iv. Animation of Hydraulic pumps: <https://www.youtube.com/watch?v=Qy1iV6EzNHg>
- v. Animation of Hydraulic pumps: <https://www.youtube.com/watch?v=pWuxYnqYDnk>
- vi. Eaton Pump assembly: <https://www.youtube.com/watch?v=sEVTIRYHoGg>
- vii. Video lectures of IIT Faculty : <http://nptel.ac.in/courses/112105047/>
- viii. Lecture series and notes by IIT faculty : <http://nptel.ac.in/courses/112106175/>
- ix. Pneumatic control valves animation: <https://www.youtube.com/watch?v=XAltNsUcES0>
- x. Pneumatic and hydraulic control valves: <https://www.youtube.com/watch?v=5EBPrdwOfAU>
- xi. Control valve symbol generation: <https://www.youtube.com/watch?v=yIot4shcOkE>
- xii. Animation of D.C Valve: <https://www.youtube.com/watch?v=jsMJbJQkGTs>
- xiii. Animation of 4/2, 4/3 D.C Valves: <https://www.youtube.com/watch?v=CQPwwWXbV3w>
- xiv. Animation of Hydraulic cylinder: <https://www.youtube.com/watch?v=bovfDsAYSbc>
- xv. Telescopic cylinder animation: <https://www.youtube.com/watch?v=icaqvFAtccY>

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Manufacturers' Catalog
5. Lab Manuals

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Cut sections of pumps, actuators, valves and accessories used in hydraulic systems	Suitably cut and mounted on a sturdy base to show the internal details.	All practical
2	Cut sections of pumps, actuators, valves and accessories used in pneumatic systems	Suitably cut and mounted on a sturdy base to show the internal details.	All practical
3	Working models of pumps, actuators, valves and accessories used in hydraulic systems	Working models mounted on sturdy base to demonstrate the operation.	All practical
4	Working models of air compressor, actuators, valves and accessories used in pneumatic systems	Working models mounted on sturdy base to demonstrate the operation.	All practical
5	Oil Hydraulic trainer	Mounted on sturdy base fitted with all standard units and accessories to create various hydraulic circuits.	LE3.1 to LE3.7
6	Pneumatic Trainer	Mounted on sturdy base fitted with all standard units and accessories to create various pneumatic circuits.	LE 5.1 to LE5.6

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2	PSO-3
CO-1 Apply the basic concepts of fluid flow to Fluid Power Systems.	2	3	3	2	1	1	2	2	1	2	-	2	2
CO-2 Explain the operation of various components of hydraulic systems.	2	3	3	2	1	1	1	2	1	2	-	2	2
CO-3 Select components required for making hydraulic circuits for simple applications.	2	3	3	2	2	1	2	2	2	2	-	2	3
CO-4 Explain the operation of various components of pneumatic systems.	2	3	3	2	2	1	2	2	2	2	-	2	3
CO-5 Select components required for making pneumatic circuits for simple applications.	2	3	3	2	2	1	2	2	2	2	-	2	3

Legend:1 – Low, 2 – Medium, 3 – High

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,4,5,6,7,8,9,10 PSO-2,3	CO-1 Apply the basic concepts of fluid flow to Fluid Power Systems.	SO1.1 SO1.2 SO1.3 SO1.4	LE1.1 LE1.2	Unit 1.0 Introduction to Fluid Power Systems 1.1-1.4	As mentioned in relevant page numbers
PO-1,2,3,4,5,6,7,8,9,10 PSO-2,3	CO-2 Explain the operation of various components of hydraulic systems.	SO2.1 - SO2.6	LE. 2.1	Unit 2.0 Elements of Hydraulic Systems 2.1-2.6	
PO-1,2,3,4,5,6,7,8,9,10 PSO-2,3	CO-3 Select components required for making hydraulic circuits for simple applications.	SO3.1 - SO3.6	LE3.1 - LE3.7	Unit3.0 Oil Hydraulic Circuits 3.1-3.6	
PO-1,2,3,4,5,6,7,8,9,10 PSO-2,3	CO-4 Explain the operation of various components of pneumatic systems.	SO4.1 - SO4.6	LE4.1 LE4.2	Unit-4.0 Elements of Pneumatic Systems 4.1-4.5	
PO-1,2,3,4,5,6,7,8,9,10 PSO-2,3	CO-5 Select components required for making pneumatic circuits for simple applications.	SO5.1 - SO5.6	LE5.1 - LE5.6	Unit-5.0 Pneumatic Circuits 5.1-5.8	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- A) Course Code : 2037574(037)
 B) Course Title : Refrigeration and Air Conditioning
 C) Pre-requisite Course Code and Title :
 D) Rationale :

The widening field of application of refrigeration and air conditioning has made it imperative for diploma holders to be well conversant with fundamental principles, concepts, devices and systems based on the refrigeration and air-conditioning. Many times they required to design, operate and maintain these systems. This subject has been included in the current syllabus to develop the basic skill required to work as a successful technical professional.

E) Course Outcomes:

CO-1 Select refrigeration method as per the situation.

CO-2 Use vapour compression and vapor absorption system as per the given situation

CO-3 Use refrigerants as per the situation.

CO-4 Apply the concept of Psychrometric behavior of air in air conditioning system.

CO-5 Estimate the cooling load as per the requirement

F) Scheme of Studies :

S. No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+(P/2)
1	Mechanical Engineering	2037574 (037)	Refrigeration and Air Conditioning	2	-	1	3
2	Mechanical Engineering	2037563 (037)	Refrigeration and Air Conditioning (Lab)	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S. No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037574 (037)	Refrigeration and Air Conditioning	70	20	30	-	-	120
2	Mechanical Engineering	2037563 (037)	Refrigeration and Air Conditioning (Lab)	-	-	-	30	50	80

Note: i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
 ii. Separate passing is must for End Semester Exam(Theory) and End Semester Exam(Practical).

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (L), Laboratory Instruction (P), T- Tutorial includes Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Select refrigeration method as per the given situation.

(Approx. Hrs: L+P+T=15)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO1.1 Explain with sketch the given refrigeration method. SO1.2 Determine the COP of the given heat pump and refrigerator. SO1.3 Plot refrigeration cycles on P-V, T-S and P-H plane. SO1.4 Use refrigeration cycle as per the situation SO1.5 Solve numerical problems SO1.6 Identify the refrigeration processes required for different climates. SO1.7 Select refrigeration method as per the situation with justification.	LE-1.1 Determine the various performance parameters using vapour compression test rig. LE-1.2 Identify the different refrigeration system and components in various application systems such as air conditioner, domestic refrigerator, water cooler etc. LE-1.3 Measure different operating parameters like pressure, temperature, humidity, velocity etc at different locations in a given system. LE-1.4 Perform performance test on heat pump.	Unit-1.0 Refrigeration and Refrigeration Cycles 1.1 Introduction to Refrigeration, different terminology of RAC machineries. 1.2 Conventional Methods of Refrigeration-Ice refrigeration, Dry ice, Steam jet, Gas throttling, Liquid Gas, Air refrigeration, Vapour absorption, Vapour compression 1.3 Non conventional methods of refrigeration -Thermo electric, magnetic, Thermo acoustic, Pulse tube, Vortex tube. 1.4 Concept of heat pump Refrigerating effect, Units of refrigeration, COP, Reversed Carnot cycle and its representation on PV and TS diagram. 1.5 Air Refrigeration Cycles: Bell Coleman cycle - representation on PV and TS diagram, determination of COP, Application of the air refrigeration cycle such as Aircraft refrigeration. Simple numerical 1.6 Vapour Compression Cycle: Schematic diagram, representation on PV, TS and PH diagrams and its working. Actual VCC, calculation of COP, Effect of Wet /Dry –compression, superheating and Sub cooling, simple numerical,	<ul style="list-style-type: none"> • Frost free refrigerator. • Portable refrigerator and chiller

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
		Multistage vapour compression cycle- need and advantages, cascade refrigeration and its application.	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

- Give the historical development in the field of refrigeration.
- Write the effect of superheating and sub cooling of refrigerant.
- Compare the performance of refrigeration systems operating on Bell Coleman and reversed Carnot cycle.

b. Mini Project:

- Identify different components of a domestic refrigerator and write down their detailed specifications.
- Make a model of earth pipe air cooling system using earth as heat exchanger.

c. Other Activities (Specify):

- Visit workshop/industry (at least 05) and collect information about the different components of commonly used refrigeration and air conditioning appliances and prepare a report on the basis of type of system, method, differences in refrigeration system, performance, comparison of refrigeration systems used by different companies etc.

CO-2 Use vapour compression and vapor absorption system as per the given situation.

(Approx. Hrs: L+P+T=22)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO2.1 Describe with sketch the construction and working of given type of compressor SO2.2 Differentiate on the basis of given characteristics open and hermetically sealed type of compressors. SO2.3 Describe with sketch the working of given type of expansion devices in VCRS. SO2.4 Compare the vapour compression and vapour absorption system on the basis of given characteristics. SO2.5 Explain the working of	LE2.1 Dismantle and assemble of Hermetic type of compressor to identify and sketch its different parts, their functions and specifications. LE2.2 Determine performance parameters using vapour absorption test rig. LE2.3 Dismantle and assemble Reciprocating type of compressor to identify its different parts, sketch, their functions and specifications. LE2.4 Determine the	Unit-2 Vapour compression and Vapour absorption refrigeration systems 2.1 Construction and working of various components- Open type, hermetically sealed, Centrifugal, Screw type compressors, Application of the compressors. 2.2 Evaporators- their functions and types such as extended surface, Plate coil type, Flooded, Dry Direct and Indirect expansion types Capacity of evaporator. Frosting /defrosting of evaporators 2.3 Condensers – types of condensers such as Evaporative type, Air cooled	• Variable refrigerant flow/Variable refrigerant volume systems

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>given absorption system.</p> <p>SO2.6 Select vapour compression and vapor absorption system for the given situation with justification.</p>	<p>performance parameters using a domestic refrigerator test rig.</p> <p>LE2.5 Determine the performance of various expansion devices on a refrigeration test rig.</p> <p>LE2.6 Identify the components of given condenser and evaporator.</p>	<p>[forced and natural convection) Water cooled</p> <p>2.4 Construction and working of various types of expansion devices such as – capillary tube auto expansion and thermostatic expansion valves, solenoid control valves and Low side High side valves</p> <p>2.5 Vapour Absorption System – Schematic diagram, principle, components and working of Ammonia vapour absorption system, Lithium Bromide absorption system, Electrolux Refrigerators , Comparison with vapor compression system</p>	

SW-2 Suggested Sessional Work (SW):

a. Assignments:

- What is metering device explain its importance on refrigeration.
- Explain why the operation of vapour absorption system is quieter than vapour compression refrigeration systems.
- Compare the vapour absorption and vapour compression refrigeration systems.

b. Mini Project:

- Visit a refrigeration workshop and observe the maintenance and repair practices of different components like compressor, evaporator and controls etc and prepare a report.

c. Other Activities (Specify):

- Prepare a PPT showing the difference between Vapour compression and Vapour absorption refrigeration systems.

CO-3 Use refrigerants as per the situation.

(Approx. Hrs: L+P+T=13)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
<p>SO3.1 Interpret the nomenclature of the given refrigerant.</p> <p>SO3.2 Differentiate primary and secondary refrigerant on the basis of its properties.</p>	<p>LE3.1 Determine the COP and refrigeration capacity of refrigerator using Freon-12, Freon-22, and Ammonia.</p> <p>LE3.2 Use leak detection method to detect the refrigerant leakage in a given setup.</p>	<p>Unit-3 Refrigerants</p> <p>3.1 Refrigerants, Description, Function, Composition and its application, Thermodynamic properties and characteristics of ideal refrigerants.</p> <p>3.2 Types of refrigerants as primary / secondary,</p>	<p>• Mixing of refrigerant and its advantages disadvantages.</p>

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO3.3 Select refrigerant for the given application with justification. SO3.4 Follow safe practices during handling of refrigerants.	LE3.3 Identify refrigerant cylinders by color coding & standing pressure. LE3.4 Recover refrigerant from the given refrigeration system during maintenance work. LE3.5 Charge refrigerant in a given system.	Properties of the Commonly used refrigerants such as – CO ₂ , Ammonia, SO ₂ , Freon 11, Freon 12, Freon 22, Azeotropes, Azeotropic and Zeotropic blends. 3.3 Secondary Refrigerants, Properties of brines and glycols. Application of various brines, Inhibitor and other secondary refrigerants Environmental impact of different refrigerants. 3.4 Nomenclature of refrigerant, Selection of refrigerants. 3.5 Next generation refrigerant, Alternatives of cfcs. 3.6 Types of cylinder, color coding, refrigerant recovery method 3.7 Safe practices in handling of refrigerants.	

SW-3 Suggested Sectional Work (SW):

a. Assignments:

- i. Give the historical development in the field of refrigerants.
- ii. Explain why the mixing of refrigerant is illegal and impractical.
- iii. Compare the given refrigerants.

b. Mini Project:

- i. Collect the samples (minimum 08) of the refrigerants and prepare a report on the basis of classification as primary and secondary refrigerants, its function, composition, properties, Nomenclature of refrigerants, its Environmental impact and its application.
- ii. Visit to nearby industry / workshop (Min. 03) and prepare a report on the basis of refrigerant handling, Types of cylinder used to handle refrigerant, color coding, refrigerant recovery method and safe practices followed.

c. Other Activities (Specify):

- i. Prepare a PPT on different method of refrigerant recovery.
- ii. Prepare a chart showing disadvantages of CFC

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

CO-4 Apply the concept of psychrometric behavior of air in air conditioning system.

(Approx. Hrs: L+P+T=15)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO4.1 Explain with example the given Psychrometric properties. SO4.2 Describe different Psychrometric processes. SO4.3 Calculate the bypass factor of cooling coil.	LE4.1 Determine DBT, WBT of ambient air using sling Psychrometer. LE4.2 Use psychrometric chart to determine DBT, WBT, RH & other properties for given situations. LE4.3 Identify the different components of given Air Conditioning Test Rig LE4.4 Use air conditioning test rig to measure sensible heating, sensible cooling, humidification and dehumidification process. LE4.5 Calculate refrigeration effect, work input, actual and theoretical COP, TOR and Plant efficiency of a given refrigerator.	Unit-4 Psychrometric 4.1 Difference between refrigeration and air-conditioning, Necessity of air conditioning, Concept of body comfort. 4.2 Properties of air - DBT, WBT, Dew Point Temperature, Relative humidity, Sensible heat, Latent heat, Air as mixture of different gases and water vapour, Daltons law of partial pressure, 4.3 Concept of humidity of air, absolute humidity, relative Humidity, Psychrometers and their types, Enthalpy of air, Specific Volume of air, Dew Point Temperature of moist air. 4.4 Psychrometric charts, psychrometric processes such as sensible heating and cooling, latent heating and cooling, heating and humidification, cooling and dehumidification, evaporative cooling, sensible heat factor, By-pass factor, apparatus dew point, simple numerical problems.	<ul style="list-style-type: none"> Psychrometric process Adiabatic mixing of air Sensible heating Sensible cooling

SW-4 Suggested Sectional Work (SW):

a. Assignments:

- Draw the various processes on psychrometric chart and write their uses in various air conditioning systems
- Identify the psychrometric process occurring in domestic air cooler.

b. Mini Project:

- Make a PPT on different psychrometric process and their use in refrigeration industry.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

CO-5 Estimate the cooling load as per the requirement.

(Approx. Hrs: L+P+T=15)

Session Outcomes (SOs)	Laboratory Instruction (P)	Class room Instruction (L)	Self Learning (SL)
SO5.1 Select the air-conditioning system for the given situation with justification SO5.2 Calculate the heating and cooling loads for the given space under different conditions.	LE5.1 Determine the cooling load of your class room. LE5.2 Estimate the cooling load due to solar heat gain in principal chamber of your institute. LE5.3 Estimate the total heat load of your institute's workshop.	Unit-5 Air Conditioning and Cooling Load Calculation 5.1 Air conditioning systems: Classification – Industrial, Comfort air conditioning, Summer, winter and year round air conditioning, Construction and working of window type, package type and central plant systems. 5.2 Cooling load calculations: Sources of heat gain – External and internal source, solar radiation through windows, heat addition by occupants and equipments, infiltration of air – ventilation, Sensible heat load, Latent heat load, Total cooling load	<ul style="list-style-type: none"> Outdoor design weather conditions and indoor design weather conditions and thermal comfort. Split AC

SW-5 Suggested Sectional Work (SW):

a. Assignments:

- Visit the nearby industrial/commercial center and list out the type of air conditioning system in use.
- Compare all air system and all water system.

b. Mini Project:

- Estimate the cooling load of computer lab of your institute.
- Estimate the cooling load of reading room of library of your institute and submit a report to HOD and Principal mentioning the changes required if any and cost involved.

c. Other Activities (Specify):

- Visit a cold storage. Prepare its layout and list down the specifications of different equipments used.
- Visit a milk chilling plant. Prepare its layout and list down the specifications of different equipments used.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESE of Classroom Instruction):

Unit Number	Unit Title	Marks Distribution			Total Marks
		R	U	A	
I	Refrigeration and Refrigeration Cycles	2	3	10	15
II	Vapour compression and Vapour absorption refrigeration systems	2	5	8	15
III	Refrigerants	2	3	5	10
IV	Psychrometric	2	3	10	15
V	Cooling Load Calculation and Air Conditioning system	2	3	10	15
Total		10	17	43	70

Legend: R: Remember, U: Understand, A: Apply and above

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

J) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Determine performance parameters on vapour compression refrigeration cycle test rig.	15	10	5
LE1.2	Identify the different refrigeration system and components in various application systems such as air conditioner, domestic refrigerator, water cooler etc.	15	10	5
LE1.3	Measure different operating parameters like pressure, temperature, humidity, velocity etc at different locations in a given system.	15	10	5
LE 1.4	Perform performance test on heat pump.	15	10	5
LE 2.1	Dismantle and assemble the Hermetic type of compressor to identify and sketch the parts, their functions, and specifications.	15	10	5
LE 2.2	Determine performance parameters on vapour absorption test rig.	15	10	5
LE 2.3	Dismantle and assemble Reciprocating type of compressor to identify and sketch its different parts, their functions and specifications.	15	10	5
LE 2.4	Determine the performance parameters using a domestic refrigerator test rig.	15	10	5
LE 2.5	Determine the performance of various expansion devices on a refrigeration test rig.	15	10	5
LE 2.6	Identify the components of given condenser and evaporator.	15	10	5
LE 3.1	Determine the COP and refrigeration capacity of refrigerator using Freon-12, Freon-22, and Ammonia.	15	10	5
LE 3.2	Use leak detection method to detect the refrigerant leakage in a given setup.	15	10	5
LE 3.3	Identify refrigerant cylinders by color coding & standing pressure.	15	10	5
LE 3.4	Recover refrigerant from the given refrigeration system during maintenance work.	15	10	5
LE 3.5	Charge refrigerant in a given system.	15	10	5
LE 4.1	Determine DBT, WBT of ambient air using sling psychrometer.	15	10	5
LE 4.2	Use psychrometric chart to determine DBT, WBT, RH & other properties for given situations.	15	10	5
LE 4.3	Identify the different components of given air conditioning test rig.	15	10	5
LE 4.4	Use Air Conditioning Test Rig to measure sensible Heating, sensible Cooling, humidification and dehumidification process	15	10	5
LE 4.5	Calculate refrigeration effect, work input, Actual and theoretical COP, TOR and Plant efficiency of a given refrigerator.	15	10	5
LE 5.1	Determine the cooling load of your class room.	15	10	5
LE 5.2	Estimate the cooling load due to solar heat gain in	15	10	5

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	principal chamber of your institute.			
LE 5.3	Estimate the total heat load of your institute's workshop.	15	10	5

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30** Marks as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Group Discussion
4. Industrial visits
5. Industrial Training
6. Field Trips
7. Portfolio Based Learning
8. Demonstration
9. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Refrigeration and Air Conditioning	Rajput R.K	S.K. Kataria, Delhi	2013
2.	Refrigeration and air conditioning (Prashitan avam Vatanukulan)	Patel S.S.L.	Standard Publishes-Distributors-Delhi	1 st edition 2010
3.	Refrigeration and Air Conditioning	Arora,	McGraw Hill Education;	3 edition ,1 July 2017
4.	Refrigeration and Air Conditioning	Khurmi R.S, gupta J.K	S. Chand	1 December 2006
5.	Principles of Air Conditioning.	Lang Paull .V	CBS publishers	3 edition 1 December 2003
6.	Refrigeration and Air Conditioning	Dr. S. V. Dingare	Nirali Prakashan	Kindle edition 31 December 2018
7.	Practical Refrigeration and Air Conditioning	M. Adithan S. C. Laroia	New Age International Private Limited	1 January 1991

(b) Open source software and website address:

Unit 1-Refrigeration and Refrigeration Cycles

- i. https://www.youtube.com/results?search_query=Air+Refrigeration+Cycles
- ii. NPTEL Source- www.nptel.ac.in/courses/112105128
- iii. <https://lecturenotes.in/notes/21511-note-for-refrigeration-and-air-conditioning-rac-by-akhil-nair>
- iv. <https://lecturenotes.in/notes/27208-note-for-refrigeration-and-air-conditioning-rac-by-rajesh-panda>

Unit 2- Vapour compression and Vapour absorption refrigeration systems

- i. https://www.youtube.com/results?search_query=1.6%09Vapour+Compression+Cycle
Vapour absorption refrigeration systems.
- ii. https://www.youtube.com/results?search_query=+Vapour+absorption+refrigeration+syste
ms
- iii. NPTEL Source- www.nptel.ac.in/courses/112105128
- iv. <https://lecturenotes.in/notes/21511-note-for-refrigeration-and-air-conditioning-rac-by-akhil-nair>
- v. <https://lecturenotes.in/notes/27208-note-for-refrigeration-and-air-conditioning-rac-by-rajesh-panda>

Unit 3-Refrigerants

- i. https://www.youtube.com/results?search_query=+Refrigerants NPTEL
- ii. Source- www.nptel.ac.in/courses/112105128
- iii. <https://lecturenotes.in/notes/21511-note-for-refrigeration-and-air-conditioning-rac-by-akhil-nair>
- iv. <https://lecturenotes.in/notes/27208-note-for-refrigeration-and-air-conditioning-rac-by-rajesh-panda>

Unit 4-Psychrometric

- i. https://www.youtube.com/results?search_query=Psychrometry+
- ii. https://www.youtube.com/results?search_query=Psychrometric+Processes
- iii. https://www.youtube.com/results?search_query=Cooling+load+calculations+
- iv. NPTEL Source- www.nptel.ac.in/courses/112105128
- v. <https://lecturenotes.in/notes/21511-note-for-refrigeration-and-air-conditioning-rac-by-akhil-nair>
- vi. <https://lecturenotes.in/notes/27208-note-for-refrigeration-and-air-conditioning-rac-by-rajesh-panda>

Unit 5-Cooling load calculation and air conditioning system

- i. NPTEL Source- www.nptel.ac.in/courses/112105128
- ii. <https://lecturenotes.in/notes/21511-note-for-refrigeration-and-air-conditioning-rac-by-akhil-nair>
- iii. <https://lecturenotes.in/notes/27208-note-for-refrigeration-and-air-conditioning-rac-by-rajesh-panda>

(c) Others:

1. Learning Packages.
2. Lab Manuals.
3. Manufacturers' Manual
4. Users' Guide

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Vapor compression test rig.	Hermetically sealed compressor, Air cooled Condenser, copper coil evaporator, thermostatic expansion valve and capillary tube, with arrangements for measurement of flow, power, pressure and temperature, equipped with filter, drier, heater and required controls. Preferably fitted with different expansion devices.	LE1.1, LE1.3, LE2.5, LE3.1
2	Cut section model of window air conditioner	Suitably cut and mounted for demonstration purposes	LE1.2
3	Cut section model of domestic refrigerator	Suitably cut and mounted for demonstration purposes	LE1.2
4	Mechanical heat pump	Hermetically sealed compressor, condenser, evaporator, expansion device, receiver tank, calorimeter, with all necessary controls and instrumentation.	LE1.4
5	Cut Section model of hermetically sealed compressor, evaporator, expansion devices, valves, condenser and controls.	Suitably cut and mounted for demonstration purpose	LE2.1
6	Vapour Absorption Refrigeration cycle test rig	Complete setup with evaporative condenser, absorber, pump, steam generator with all other required components to evaluate the performance.	LE2.2
7	Reciprocating compressor model	Suitable for assembling/dismantling	LE2.3
8	Domestic Refrigerator test rig	Hermetically sealed compressor, coil tube heat exchanger, capillary expansion device, coiled tube type evaporator, fitted with all controls and accessories required for calculating performance parameters.	LE2.4
9	Electronic leak detector	Suitable for detecting leakages of CFCs, HCFCs, HFCs and FCs	LE3.2
10	Refrigerant recovery unit	Suitable for recovery of CFCs, HCFCs, HFCs and FCs with all controls and instrumentation	LE3.4
11	Gas Charging kit	Complete charging kit consisting of vacuum pump, gas cylinder, manifold, shut off valves, filter cum drier, pressure gauge, anti moisture tube, charging hose pipe, controls, mounted on a movable trolley.	LE3.5
12	Refrigerants	CFCs, HCFCs, HFCs, FCs as required	LE3.3
13	Refrigeration and air conditioning tools	Necessary tools and accessories like brazing torch, gas charging cylinder, capillary tube gauge, pipe and machinist vice, capacitor analyzer, copper tube cutter, tube bender, flaring tool, pinching tool oxy-acetylene torch, tube reamer, wrenches, crimping tool, charging hose pipe, vacuum pump, copper tubes of various sizes.	LE3.4, LE3.5
14	Air conditioning test rig	Hermetically sealed compressor, Air cooled	LE4.3

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
		Condenser, Air calorimeter type evaporator, thermostatic expansion valve, with arrangements for measurement of flow, power, pressure and temperature, equipped with heater, duct, boiler and blower.	
15	Different types of expansion devices, cut outs, valves if required can also be procured.		

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1 Modern Software Usage	PSO-2 Equipment and Instruments	PSO-3 Mechanical Engineering Processes
CO-1 Select refrigeration method as per the situation.	3	3	3	2	1	3	1	1	1	3	1	2	1
CO-2 Use vapour compression and vapor absorption system as per the given situation.	3	3	2	2	1	2	1	1	1	3	1	2	2
CO-3 Use refrigerants as per the situation.	3	3	3	2	1	3	1	1	1	3	1	2	2
CO-4 Apply the concept of Psychometric behavior of air in air conditioning system.	3	3	2	2	1	1	1	1	1	3	1	1	3
CO-5 Estimate the cooling load as per the requirement.	3	3	3	2	1	1	1	1	1	3	1	2	2

Legend:1 – Low, 2 – Medium, 3 – High

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

O) Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (P)	Classroom Instruction (L)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2,3	CO-1 Select refrigeration method as per the situation.	SO1.1 - SO1.7	LE1.1 - LE 1.4	Unit-1.0 Refrigeration and Refrigeration Cycles	As mentioned in relevant page numbers
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2,3	CO-2 Use vapour compression and vapor absorption system as per the given situation.	SO2.1 - SO2.6	LE2.1 - LE2.6	Unit-2.0 Vapor compression and Vapor absorption refrigeration systems	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2,3	CO-3 Use refrigerants as per the situation.	SO3.1 - SO3.4	LE3.1 - LE3.5	Unit-3.0 Refrigerants	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2,3	CO-4 Apply the concept of Psychrometric behavior of air in air conditioning system.	SO4.1 - SO4.3	LE4.1 - LE4.5	Unit-4.0 Psychrometric	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2,3	CO-5 Estimate the cooling load as per the requirement.	SO5.1 SO5.2	LE5.1 - LE5.3	Unit-5.0 Cooling Load Calculation and Air Conditioning systems	

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Mechanical Engineering

Semester-V

- A) Course Code : 2037565(037)
 B) Course Title : Industrial Visit, Industrial Training and Internship
 C) Pre- requisite Course Code and Title :
 D) Rationale :

With the advancement in technology and industry, we need to prepare our young Indian technical talent to meet the present demand. Our diploma passouts are either supposed to work as supervisor in the industries or start their own enterprise, hence upon the completion of diploma programme, they need to be adequately equipped with knowledge, skills and attitude required by the world of work in their relevant field. To attain this, students need to be sent for industrial visit and industrial training during the course of study. With these provision of industrial exposures relevant practical and professional skills are developed in the students and as a result of this students are readily employed and widely accepted by cross section of the industries, even sometimes during such training itself.

Series of continues interactions with the industry personnel are required to be done for planning and arranging and also effectively implementing such exposures.

- E) **Course Outcomes:** After undergoing the industrial visit, industrial training and internship the students will be able to -

CO-1 Appreciate the importance of industrial visit, industrial training and internship for gaining direct practical skills on their relevant domain area.

CO-2 Comprehend the comprehensive view of industry or world of work in terms of its layout, management, culture, hierarchy, discipline, safety norms, different department/sections, quality control/assurance in processes, services and products, demonstration and operation of specific equipment/machinery, rules and procedures etc.

- F) **Scheme of Studies:**

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Total Credits(C) L+T+(P/2)
1	Mechanical Engineering	2037565 (037)	Industrial Visit, Industrial Training and Internship	-	2	-	1

Legend: L: Classroom Instruction (Includes different instructional strategies i.e. Lecture and other), P: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) T- Tutorial includes Sessional Work(SW) (includes assignment, seminar, mini project etc.) and Self Learning (SL), C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

- G) **Scheme of Assessment:**

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Mechanical Engineering	2037565 (037)	Industrial Visit, Industrial Training and Internship	-	-	-	50	30	80

- Note** i. Separate passing is must for TA component of Progressive Assessment, both for theory and practical.
 ii. Separate passing is must for End Semester Exam (Theory) and End Semester Exam(Practical).

Guidelines to teachers for Industrial Visit, Industrial Training and Internship are given below:

H) Guidelines to Teachers for arranging Industrial visit :

1. Rationale :

During implementation of the curriculum, industrial exposure in the form of industrial visit is very important for developing and reinforcing many concepts and principles and also to get an idea to understand the industrial environment, working culture and latest developments in relevant field and many other aspects of the industries, where diploma holders are going to be absorbed. Students also get exposed to the different kinds of problems which can be brought into the institutional laboratories or workshop. Planning before industrial visit and Industrial tour is essentially required to be done or effective implementation of the same.

2. Planning for industrial visit :

During industrial visit of students to develop certain expected outcomes, many dimensions or aspects of industries need to be understood. The major dimensions or aspects of industry's visit which may be taken care of during the industrial visit are as below –

- Layout of different Departments, Sections of Industry, stores, entry and exit etc.

S.N	Major Dimensions /Aspects of Industrial Visit
I.	Layout of different Departments, Sections of Industry, stores, entry and exit etc.
II.	Display of Quotations in the Industry
III.	Display of Charts on - <ul style="list-style-type: none">• Systems of Industry• Procedures/Rules/standards• Hierarchy at Industries• Products & Services• Targets• Safety Precautions/Norms• Flow diagrams of different process• Other Aspects
IV.	Demonstration of Specific Equipment, not available in the Institute or Department or even the Demonstration of Performance of Specific Experiment.
V.	Demonstration of latest Engineering Tools or Techniques or Software's or Procedures

*Assessment rubric may be prepared by the implementing teachers in advance for assessing the students on various dimensions of industrial visit.

3. Major outcomes expected to be attained and assessed :

Outcomes expected from the industrial visit should be clearly defined and briefed to the students. Evaluation criteria for assessing students, need to be prepared for different outcomes set, during the planning stage. The list of major outcomes expected to be attained are –

- Development and reinforcement of Basic knowledge
- Development and reinforcement of Engineering knowledge through reinforcement of concepts or principles
- Outcome attainment through content beyond syllabus
- Engineering and Society
- Environment & Sustainability
- Communication ability

- Industrial System and its development
- Safety Awareness
- Systematic Operations and Productions
- Quality control
- Management of work place and work force
- Development of positive attitude
- Work culture/Quality Culture
- Development of Professional Ethics
- Industrial Management
- Systematic planning, Implementation & Evaluation
- Use of engineering tools, techniques, softwares and Procedures
- Development of Lifelong learning skills

It is important to note that outcomes attained during industrial visit are at the awareness level only.

I) Guidelines to Teachers for arranging Industrial Training :

1. Rationale :

Apart from arranging industrial visit, organizing industrial training of students is essentially required to be done during implementation of the curriculum to improve the quality of our young diploma engineering students and to enhance the prospects of employability. After undergoing industrial training, students get the direct exposure to the world of work in their relevant field. They get hands on experience in the industries. The need to be given opportunity to undergo training in relevant industry for minimum two weeks and it is recommended that it should be mandatory for all the programmes running in the institute. The industrial training period may vary from 2 weeks to 6 months depending upon the requirement of that programme.

The programmes, where there is provision of industrial training during the semester are termed as sandwich programmes. Many of the programmes have industrial training at the end of last semester or sometimes a full semester is dedicated for industrial training.

2. Planning for Industrial Training :

Following points need to be planned and briefed by the teachers to the students before proceeding for industrial training. Student should take into consideration these points and carry the relevant format/data/log book with them.

- Objectives /Purposes of the industrial training
- Outcomes targeted before proceeding to industrial training.
- Pre-requisite knowledge or skills required to be developed in the students in the form of demonstration or classroom sessions.
- Identification and planning for demonstration of any equipment or experiments, concepts, under the content beyond syllabus.
- Preparation of database of nearby relevant industries.
- Good rapport need to be developed and maintained with the industries by the teachers, so that the students are ultimately benefitted by the industrial training.
- Industrial policy of the state also need to be taken care of while planning of industrial training
- For assessing the students on various dimensions of industrial training, assessment rubric may be prepared by the implementing teachers in advance.
- Following formats need to be developed by the teachers and briefed to the students before proceeding to industrial training –
 - Formats of observations on layout, ambience, and work culture to be developed, and briefed to the students.

- Formats of outcome attainment, related to observation on relevant technical area also need to be developed by the teachers and briefed to the students.
- Formats and contents of report writing and presentation.
- Formats and contents on assessment of industrial training.
- Continuous observation formats on many points such as behavioral aspects related to soft skills development such as initiativeness, observation, notes taking skills, inquisitiveness, obedience, sincerity, follow the instructions, positive attitude and many other aspects.
- Formats of Assessment Rubric on different parameters of both behavioral aspects and technical aspects of the programme.

3. Actions to be taken by the Students and Teachers :

Students are sent to Industrial training after briefing on various aspects. During industrial training, observational skills in students are required to a great extent -

- Students need to be alert, meticulous and record the data, as briefed to them before the industrial training.
- Record of observations on safety precaution to be followed, any special point during performance and handling of equipment, performance on technical aspects and other related aspects need to be taken care of.
- Continuous observation, monitoring and assessment on various behavioral and performance of technical aspects of each student need to be critically observed and recorded by the teachers using different assessment tools.

4. Post Training Assessment :

The students need to be assessed on report writing, presentation and interpretation of data recorded, on various dimensions, planned and performed, after the industrial training. The actions are required to be taken for assessment during report writing, analysis, interpretation, presentation of data and its assessment.

5. Major outcomes expected to be attained and assessed :

The following learning outcomes are expected to be developed during the industrial training. This will lead to attainment of COs, POS and PSOs.

- Development and Reinforcement of Basic Knowledge/concepts
- Development and Reinforcement & Engineering Knowledge i.e operations, performance, maintenance, demonstrations of specific skills relevant to the content of the programme.
- Experiment and practice – Development of experimental practical skills and technical skills relevant to the course programme.
- Development of learning to learn skills and lifelong learning skills for latest advancement in technology.
- Development of positive attitude, professional ethics and etiquettes.
- Development of skills for individual and team work during performance and otherwise.
- Maintaining Business Secrecy
- Development of Communication Skills
- Ability to follow the instructions
- Ability to follow the safety precautions
- Ability to supervise the task
- Ability to coordinate with subordinates and higher ups
- Development of Interpersonal skills
- Environmental Consciousness and Sustainability
- Development of Observational Skills
- Time Management

- Self discipline
- Integrity
- Development of generic skills such as pro-activeness, commitment
- Development of Problem Solving abilities
- Achievement of target

J) Guidelines to Teachers for arranging Internship :

1. Rationale :

The concepts of internship is the need for the development of outcomes based in the students. It encourages on the job-training, practice, feedback and reinforcement of concepts and principles. During internship students are exposed to variety of task/problems/assignments which enhances the exposure of students to cross section of different real situations. Continuous feedback on the job helps in sharpening of the outcomes to be attained in the relevant field.

2. Planning for Internship :

The advantages of providing internshala platform to the students are enormous. Some of these are :

- Free access to 4th Lakhs internships (both part-time and full time).
- A chance to earn a certificate and a stipend.
- Additional 10% discount on all Internshala training to students.
- The T&P official of every college will who receive a monthly performance report of their students on Internshala.
- Once the institutions are registered with the Internshala. Registration is done through the website internshala.com/i/register-rgpv. Details of students (name, e-mail & phone no.) are uploaded in an excel sheet. Internshala will create an account for all the students so that they can apply for internship. The registration is free of cost.

For assessing the students on various dimensions of internship, assessment rubric may be prepared by the implementing teachers in advance

3. Major outcomes expected to be attained and assessed :

The following learning outcomes/skills are expected to be developed through internship. This will lead to attainment of COs, POS and PSOS.

- Development and Reinforcement of Basic Knowledge/concepts
- Development and Reinforcement & Engineering Knowledge i.e operations, performance, maintenance, demonstrations of specific skills relevant to the content of the programme.
- Experiment and practice – Development of experimental practical skills and technical skills relevant to the course programme.
- Development of learning to learn skills and lifelong teaching skills for latest advancement in technology.
- Development of positive attitude ethics values and etiquettes.
- Development of skills for Individual and Team work during performance and otherwise.
- Maintaining Business Secrecy
- Development of Communication Skills
- Ability to follow the instructions
- Ability to follow the safety precaution
- Ability to supervise the task
- Ability to coordinate with subordinates and higher ups

- Development of Interpersonal skills
- Environmental Consciousness and Sustainability
- Development of Observational Skills
- Time Management
- Self discipline
- Integrity
- Development of generic skills such as pro-activeness, commitment
- Development of Problem Solving abilities
- Achievement of target

K) Initiatives by Govt. of India and other Agencies :

1. Initiatives by Govt. of India, GOI

a. Initiatives by Ministry of Skills Development and Entrepreneurship

Many efforts are initiated by different agencies in this direction as per our Prime Minister's Skills Development Mission. Make in India, Skills India etc are such initiatives taken by ministry for the benefit of the students.

b. Initiatives by Ministry of HRD, Govt. of India

- I. Ministry of HRD, Government of India is providing students a platform to inculcate a culture of product innovation and a mindset of problem solving to solve some of pressing problems solving to solve some of pressing problems we face in our daily lives through Smart India Hackathon (SIH) 2019.

In SIH-2019, the students would also have the opportunity to work on challenges faced within the private sector organizations and create world class solutions for some of the top companies in the world, thus helping the private sector hire the best minds from across the nation. The team size for participation in one team will be 8 (6 Students + 2 Mentors). 50 Teams will be selected for the final Hackathon. The prize will be a cash prize for each rank with following distribution criteria for the top three teams ranging from Rs. 50,000 to 1,00,000/-.

- II. **Internshala** : Internshala is India's largest internship and training platform where more than 80,000 companies look for interns in various profiles (Engineering, management, media, arts etc.) AICTE has also partnered with Internshala for providing internship opportunities to every students in AICTE approved colleges. This facility is created to provide a platform for hands on experience to the our future technicians on the relevant industries. With this experience, they are updated with the latest advances in their field of work.

Government of India through, AICTE is engaged in promoting the concept of industrial training through its various scheme, such as Internshala. The teachers now have the responsibility to understand in depth and implement such schemes in the institution for the benefit of students. At institute level also, there is need to develop policy for sending the students for industrial training.

c. Initiatives by Ministry of Labour and Employment, Govt. of India

Ministry of Labour and Employment, Government of India launched a National ICT based job portal known as National Career Service (NCS) portal to connect the opportunities with the aspirations of youth. This portal facilitates registration of job seekers, job providers, skill providers. Career counselors, etc. The portal provides job matching services in a highly transparent and user friendly manner. These facilities along with career counseling content are delivered by the portal through multiple channels like career centres, mobile devices, CSCs, etc.

The portal provides information on over 3000 career options from 53 key industry sectors. Job seekers also have access to industry trends in a user friendly way. The NCS portal links job-seekers, employers,

counselors and training providers all through Aadhaar-based authentication. Registration to NCS portal is online and free of charge. The salient feature of NCS portal includes the following :

- Career counseling and Guidance
- Enabling Skill Development
- Empowering Job seekers to find the right Job
- Enabling employers to pick the right talent
- Enhancing capabilities of students through training

Information's related to Job Fairs/Placements

d. Initiatives by Telecom Sector Skill Council (TSSC)

TSSC has taken a step towards fulfilling the emerging requirements of the industry by partnering with key stakeholders in order to bring the latest content to the forefront. TSSC have got into partnership with All India Council for Technical Education (AICTE) for summer internship programme and various other MNCs to impart Skilling in new emerging technologies. Some of the prime courses in new emerging technologies being offered by TSSC in addition to TSSC Qualification packs are as under :

- Artificial Intelligence & Data Science
- Cyber Security
- Internet of Things
- Android
- AR/VR

In addition to this certain courses on life skills/soft skills, employability related skills are also planned for the students such as

- Problem solving and analytic
- Communication skills
- Lifelong learning
- Behavioral Skills
- Professional Behavioral etc.

The main objectives of TSSC are as follows:

- Bridge the gap and enhance employability of our students
- Training young minds towards 21st Century skills assisting industry cross-sector
- Meet the needs of school leavers and graduates, employers, government educational institutions and society.
- Address the need for quality, skill training for human resources to complement the large goal of accomplishing the include growth.
- Address the limited capacity of skills development facilities in India
- To develop extensive placement linkages with employers in all sectors to provide gainful entry-level employment opportunities to youth undergoing the skill training.
- Industry participation in developing the skill training solutions to address critical skill gaps by standardization of training content, delivery and assessment process o improve overall competitiveness of the industry.

2. Initiatives by other agencies

a. Initiatives by Engineering Council of India (ECI)

(ECI has also taken initiatives to organize series of interactive workshops to update and apprise the students about the products and services being offered by respective corporate house. This interaction will definitely bring the institute and industry closer and help in planning for effective implementation of industrial training.

b. Others

Many public sector and private organizations are also contributing to the course of quality improvement in technical education system by way of arranging industrial visit of providing industrial training to the students as a part of their corporate social responsibility and also for the growth of technical education system of the country.

L) Initiatives to be taken by State Technical University/Board/Institutions.

- State Technical University/Board have to sign MOU with Internshala, partner of AICTE, with the aim of providing students with professional experience in the form of internship. For registration of students at college level for Internshala platform, visit of website address internshala.com/i/register-rgpv is suggested for uploading the details (Name, e-mail address & phone number compulsory) in an excel sheet. Internshala will create an account for all the students so that they can apply for internship. The registration is free of cost.
- Programme wise Industries Bank of nearby industries at state level and national level need to be created for useful interaction with details of content e-mail addresses phone numbers and areas of expertise.
- Institute may take initiative to facilitate the registration of students at National Career service (www.ncs.gov.in) portal and ensure the compliance of above directive in your institute.
- Institute should encourage and facilitate the registration of team of students for Smart India Hackathon-2019 at www.sih.gov.in portal and other similar websites.
- After careful curriculum analysis and also identifying the learning gaps, an action plan for effective implementation of the course need to be prepared based on the area of industries. This would help the teachers to decide the particular industry to be visited for exposing to specific content area or specific outcomes to be attained.
- Frequent Industry – Institute meet may be arranged on different topics for mutual benefit.
- List of a directory of industrial experts may be prepared for inviting them for seeking their expertise.
- Guidelines/policy for sending students to industrial training/internship must be prepared by the university for effective implementation of the industrial training/internship.
- TOT programmes on orientation of arranging industrial visit, training should be arranged for teachers implementing the same.
- MOU between University and Industry need to be signed for -
 - Industry collaboration for student/faculty empowerment
 - Partnership with industry on curriculum implementation.
 - Demonstrating and performing practical performances to students.
 - Providing technical work force for industrial production.
 - Corporate support to Academia through various resources.
- Establishment of training and placement cell at each institute level.
- Employability Enhancement initiatives need to be taken by CSVTU for arranging campus placement at CSVTU level/institute level or through open campus.

M) References:

- **What is Industrial Visit & Benefit's of Industrial's Visit**
<http://education.osrvacation.com/what-is-industrial-visit-benefits-of-industrials-visit/>
- **Importance of Industrial visit**
<http://industrialtour.com/importance-of-industrial-visit/>
- **Difference Between Training and Internship**
<https://keydifferences.com/difference-between-training-and-internship.html>
- **INTERNSHIP VS INDUSTRIAL TRAINING – ANY DIFFERENCE?**
<http://www.careerhubafrica.com/blog/internship-vs-industrial-training-any-difference/>
- **What is an Internship?**
<https://www.wikijob.co.uk/content/internships/advice/what-internship>
- **5 Elements to Include in any Post Training Evaluation Questionnaire**
<https://www.efrontlearning.com/blog/2017/12/element-post-evaluation-training-questionnaire.html>