Program : **Diploma in Automobile Engineering**	
Course Code : **5051**	Course Title: **Design of Automotive Components.**
Semester : **5**	Credits: **4**
Course Category: **Program Core**	
Periods per week: **4 (L:3, T:1, P:0)**	Periods per semester: **60**

Course Objectives:

- To assess various vehicle components and to conduct the failure analysis.
- To appreciate the process of designing various components.
- To provide necessary factor of safety to the vehicle according to its usage.
- To develop an ability to identify, formulate, and solve engineering problems.
- To develop an ability to design a system or component to meet desired needs within realistic constraints.

Course Prerequisites:

Topic	Course code	Course Title	Semester
Knowledge of basic science		Applied Physics I	1
Knowledge of basic science		Applied Physics II	2
Knowledge of basic science		Mathematics I	1
Knowledge of basic science		Mathematics II	2
Knowledge of program core course		Material Science and strength of materials.	4
Knowledge of program core course		Manufacturing technology for automobile components	3
Knowledge of program core course		Automobile Chassis and transmission	4

Course Outcomes:

On completion of the course, the student will be able to:

COn	Description	Duration (Hours)	Cognitive level
CO1	Explain design procedure, principles of ergonomics and basic link mechanism.	14	Understanding

CO2	Identify the equations to design shaft, keys and couplings.	15	Applying
CO3	Develop the design of clutch, gears , belt drive and chain drives.	14	Applying
CO4	Develop cam profile, engine cylinder, piston and connecting rod design.	15	Applying
	Series Test	2	

CO – PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2						
CO2	2	2					
CO3	2						
CO4	2						

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

Course Outline:

Module Outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Explain design procedure, principles of ergonomics and basic link mechanism.**		
M1.01	Classify types of design and explain design procedure for machine elements.	2	Understanding
M1.02	Explain the principles of ergonomics and aesthetics in designing automobile components.	2	Understanding
M1.03	Summarize basic link mechanism.	2	Understanding
M1.04	Illustrate inversions of four bar chain	2	Understanding
M1.05	Illustrate inversions of single slider crank chain	3	Understanding
M1.06	Illustrate inversions of double slider crank chain	3	Understanding

Contents:

Fundamentals of Design.

Introduction to design. Classification of design (Adaptive design, Development design, New design)

Factors governing the design of machine parts.

General design procedure for machine elements.

Design Stress, Working stress and Factor of Safety.
Stress - strain diagram for ductile and brittle material.

Introduction to theories of Elastic Failures.

Maximum principal stress theory.

Maximum shear stress theory.
Principles of Ergonomics, Aesthetics in designing automobile components.

Ergonomics of Design: Man- Machine relationship; Design of Equipment for control, environment & safety; Aesthetic considerations regarding shape, size, color& surface finish.

Basic link mechanism:

Definition - Kinematic link or element, kinematic pair, lower pair and higher pair, kinematic chain, constraint motions - Types of constrained Motions.

Definition of Machine, Structure and Mechanism. Difference between Machine, Mechanism and Structure.

Inversions - Types of Kinematic Chains - Four Bar Chain - Single Slider Crank Chain - Double Slider Crank Chain

Inversions of single slider crank chain: Oscillating cylinder engine - Crank and slotted lever quick return mechanism - Bull Engine (Pendulum pump)

Inversions of double slider crank chain:

1) Elliptical trammel.

2) Scotch yoke.

3) Oldham's coupling

CO2	**Identify the equations to design shaft, keys and couplings**		
M2.01	Compare shaft, axle and spindle.	1	Understanding
M2.02	Develop design procedure of shafts subjected to twisting moment only.	1	Applying
M2.03	Solve problems on design of shafts subjected to twisting moment only.	1	Applying
M2.04	Develop design procedure of shafts subjected to bending moment only.	1	Applying
M2.05	Solve problems on design of shafts subjected to bending moment only.	1	Applying
M2.06	Develop design procedure of shafts subjected to bending moment and twisting moment only.	1	Applying

M2.07	Solve problems on design of shafts subjected to bending moment and twisting moment only	1	Applying
M2.08	Explain the purpose, Types and Forces acting on sunk key	1	Understanding
M2.09	Identify the design procedure of Sunk Keys based on shear & crushing and solve problems	1	Applying
M2.10	Explain the functions, requirements and Types of various couplings	1	Understanding
M2.11	Design Muff and unprotected type Flange Coupling	1	Applying
M2.12	Explain various types of bearings Solve problems on the design of Thrust bearings.	2	Applying
M2.13	Solve problems on the Design of Thrust bearings.	2	Applying
	Series Test -I	1	

Contents:

Design of shaft, keys and couplings

Shafts:

Types of Shafts

Differentiate between shaft, axle and spindle - Power transmitted by the shaft. Design of (solid and hollow) shafts subjected to twisting, bending, and combined twisting and bending moment - Design of shaft using strength and rigidity criteria .

Keys:

Purpose, Types - Taper key - parallel key - sunk key - saddle key - Gib head key - woodruff key feather key - splines, Forces acting on sunk key - Design of Sunk Keys based on shear & crushing Simple problems

Couplings:

Functions - requirements - Types. Design of Muff Coupling - Design of Unprotected type Flange Coupling

Bearings:

Function and Classification of bearings - {Sliding contact bearing: Journal bearings- Bushed bearing, Plummer block. Thrust bearings - Footstep bearing, Collar bearing. Rolling contact bearing: Ball bearings, Roller bearings, Needle bearings}- Properties of bearing materials.

Advantages and disadvantages of antifriction bearings (rolling contact) over sliding contact bearings - Designation of rolling contact bearing - Design of Thrust bearings (Simple problems).

CO3	Develop the design of clutch, gears, belt drive and chain drives.		
M3.01	Identify the function of clutch and its applications.	1	Applying
M3.02	Develop the design of single plate clutch using uniform pressure and uniform wear condition.	1	Applying
M3.03	Solve problems on design of single plate clutch using uniform pressure and uniform wear condition.	2	Applying
M3.04	Develop the design of multi plate clutch using uniform pressure and uniform wear condition.	2	Applying
M3.05	Solve problems on design of multi plate clutch using uniform pressure and uniform wear condition.	1	Applying
M3.06	Make use of spur gear terminology and types of gear trains.	1	Applying
M3.07	Solve problems on gear ratios of automobile gear box.	1	Applying
M3.08	Summarize types of belts, materials, slip and creep of belts	1	Understanding
M3.09	Solve problems on the determination of length of open and closed belt, ratio of belt tensions and maximum power transmission.	2	Applying
M3.10	Solve problems on the design of belt dimensions.	1	Applying
M3.11	Outline the types, advantages and disadvantages of chain drive.	1	Understanding

Contents:

Design of Chassis components

Design of clutch

Function of Clutch and its application. Design of Single plate and Multi plate clutches, using uniform pressure and wear condition - Problems on clutches.

Power Transmission

Gear and gear trains:

Spur gear terminology; Types of gears and gear trains. Train value & Velocity ratio for Simple, Compound, and Reverted gear trains. Simple problems on gear drives. Calculation of number teeth of gear and gear ratios of automobile gearbox.

Belt drive and chain drive

Types of belt and belt materials - flat belt drives and v-belt drives. Velocity ratio, slip and creep of belt drive. Determination of the length of open and closed belt drives. Determination of, ratio of belt tensions in flat belt. Maximum power transmitted by belt (without proof). Design of belt dimensions (without considering centrifugal tension).

Chain Drives - Advantages & Disadvantages; Types of chain - roller type and silent type.

CO4	**Develop cam profile, engine cylinder, piston and connecting rod design.**		
M4.01	Classify and compare followers and cams	1	Understanding
M4.02	Explain the terminology of cam.	1	Understanding
M4.03	Construct the displacement diagram and cam profile of radial cam with knife edge, roller and flat faced with or without offset under following types of follower motions. (uniform velocity, simple harmonic motion and uniform acceleration and retardation)	7	Applying
M4.04	Explain the design procedure of cylinder and cylinder head.	1	Understanding
M4.05	Solve the problems on design of cylinder and cylinder head.	1	Applying
M4.06	Explain the design procedure of I.C engine piston.	1	Understanding
M4.07	Solve the problems on design of I.C engine piston	1	Applying
M4.08	Identify the design procedure of connecting rod.	1	Applying
M4.09	Solve the problems on design of I.C engine connecting rod (I -section)	1	Applying
	Series Test -II	1	

Contents:

Design of Engine Components:

Cams - Introduction - Classification of followers and Cams - Terminology of cam - Displacement diagram for the following Motion of Follower - Uniform velocity - Simple Harmonic Motion (SHM) - Uniform Acceleration and Retardation Motion (UARM). Cam profile construction of radial cam with knife - edge, roller follower and flat faced follower with and without offset.

Design of cylinder, cylinder head, piston, connecting rod

Design of Engine cylinder and cylinder head

Engine cylinder - function. Design of Engine cylinder (bore & length of cylinder, Thickness of cylinder wall, head thickness,) - simple problems

Design of piston

Piston - function - design considerations for a piston. Design of piston (piston crown, piston rings, piston skirt, piston pin) - simple problems.

Connecting rod

Connecting rod - function - Forces acting on the connecting rod. Design of connecting rod cross - section (I section) - simple problems.

Text / Reference:

T/R	Book Title/Author
T1	R.S. Khurmi - Machine design – Eurasia publication house
R1	R.S. Khurmi, J.B. Gupta - Theory of machines - Eurasia publication house (PVT) LTD.
R2	Anil Chhikara - Automobile Engineering Vol. 2 - Satyaprakasan
R3	J G Giles - Auto engine design -Illiffe
R4	Thomas Beven - Machine Design –Pearson India
R5	R.B.Gupta - Auto design – Satyaprakasan
R5	Dr. P.C. Sharma, Dr. D.K. Agarwal- Machine Design-S.K. Kataria & Sons.
R6	M. Chakraberti- Strength of materials- S.K. Kataria & Sons.

Online Resources:

Sl.No	Website Link
1	https://nptel.ac.in/courses/112/105/112105125/
2	http://nptel.ac.in/courses/112107146
3	http://nptel.ac.in/courses/116102012/8
4	http://nptel.ac.in/courses/112104203/31
5	http://nptel.ac.in/courses/116102012/26