AUTOMOBILE COMPONENT DESIGN II

ENAM 413

Lecture	**: 3**	**Year : IV**
Tutorial	**: 1**	**Part : I**
Practical	**: 3/2**	

Course Objectives:
The objective of this course is to provide strong foundation in the principles and practices of designing major automobile components. The course emphasizes the systematic design and analysis of internal combustion engine components, braking systems and suspension elements.

1 Fundamentals of Design (8 hours)

- 1.1 Types of models
  - 1.1.1 Significance in automobile engineering, mathematical modeling and principles of similitude
  - 1.1.2 Finite element modeling and its analytical applications
- 1.2 Optimization techniques
  - 1.2.1 Differential calculus, search techniques, multivariable search methods
  - 1.2.2 Linear and geometric programming and multifactor objective optimization functions
- 1.3 Product design considerations
  - 1.3.1 Design for manufacturability and ease of assembly
  - 1.3.2 Design for reliability and safety
  - 1.3.3 Design for quality and robustness
  - 1.3.4 Design for testing
  - 1.3.5 Design for sustainability and environmental impact
- 1.4 Risk, reliability and safety
  - 1.4.1 Application of probabilistic approach in design problems
  - 1.4.2 Fundamentals of reliability theory, failure rates and system reliability
  - 1.4.3 Hazard identification and analysis
  - 1.4.4 Fault tree analysis for automobile engineering applications

2 Design of Engine Cylinder Assembly (3 hours)

- 2.1 Materials and manufacturing process for the cylinder and cylinder head
- 2.2 Design of cylinder parameters: Bore, length and wall thickness
- 2.3 Design of the cylinder head based on the stresses on the cylinder
- 2.4 Design of studs for the cylinder head

3 Design of Engine Piston Assembly (4 hours)

3.1 Materials and manufacturing process for the engine piston, piston pins and piston rings
3.2 Design of piston head, ribs and cup
3.3 Design of piston rings, barrel, skirt and pin

4 Design of Engine Connecting Rod Assembly (4 hours)

4.1 Materials and manufacturing process for the engine connecting rod
4.2 Design of the connecting rod and its cross-section
4.3 Buckling of the connecting rod
4.4 Design of big and small end bearings, cap and bolts

5 Design of Engine Crankshaft Assembly (8 hours)

5.1 Materials and manufacturing process for the engine crankshaft
5.2 Design of crankshaft (Centre and side type)
5.3 Design of the centre crankshaft at top-dead centre position
5.4 Design of the centre crankshaft at the angle of maximum torque
5.5 Design of the side crankshaft at top-dead centre position
5.6 Design of the side crankshaft at the angle of maximum torque

6 Design of Valve Mechanism Assembly (5 hours)

6.1 Materials and manufacturing process for valves, rocker arm, valve spring and push rod
6.2 Design of valves
6.3 Design of the rocker arm
6.4 Design of valve spring
6.5 Design of push rod

7 Design of Clutches and Brakes (8 hours)

7.1 Internal expanding rim clutches and brakes
7.2 External expanding rim clutches and brakes
7.3 Band-type clutches and brakes
7.4 Frictional contact axial clutches
7.5 Cone clutches and brakes
7.6 Energy consideration and temperature rise

8 Design of springs (5 hours)

8.1 Stresses in a helical spring
8.2 Deflection of a helical spring
8.3 Extension and compression springs
8.4 Spring materials: Estimation of tensile strength and torsional yield strength

8.5 Design of a helical spring along with fatigue loading
8.6 Leaf spring

Tutorial **(15 hours)**

1. Computational analysis of engine cylinder assembly parameters
2. Stress and structural evaluation of the engine piston assembly
3. Buckling and cross-sectional design of the connecting rod
4. Analysis of crankshaft assemblies at critical crank positions
5. Kinematic and force calculations for valve mechanism components
6. Torque and thermal energy calculations for clutches and brakes
7. Fatigue and deflection modeling of helical and leaf springs

Practical **(22.5 hours)**

1. Modeling and simulation of engine cylinder assembly parameters
2. FEA-based structural analysis of the engine piston and ring assembly
3. Computational stress and buckling study of the connecting rod
4. Design and kinematic verification of the engine crankshaft assembly
5. Simulation-aided design of valve mechanisms and cam profiles
6. Thermal and frictional modeling of clutches and brake systems
7. Computational optimization of spring characteristics and fatigue life

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	8	12
2	3	4
3	4	6
4	4	6
5	8	10
6	5	6
7	8	10
8	5	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Bhandari, V. B. (2017). Design of machine elements. McGraw-Hill Education.
2. Budynas, R. G., & Nisbett, J. K. (2020). Shigley's mechanical engineering design. McGraw-Hill Education.
3. Dieter, G. E., & Schmidt, L. C. (2021). Engineering design. McGraw-Hill Education.

4. Giri, N. K. (2013). Automobile mechanics. Khanna Publishers.
5. Norton, R. L. (2019). Design of machinery: An introduction to the synthesis and analysis of mechanisms and machines. McGraw-Hill Education.