## SEMESTER S7

# ADVANCED AUTOMOTIVE MANUFACTURING MATERIALS

| Course Code | PEAUT745 | CIE Marks | 40 |
|---|---|---|---|
| Teaching Hours/Week (L: T:P: R) | 3:0:0:0 | ESE Marks | 60 |
| Credits | 5/3 | Exam Hours | 2 Hrs. 30 Min. |
| Prerequisites (if any) | | Course Type | Theory |

**Course Objectives:**

1. To understand the fundamental properties of various materials used in automotive manufacturing, such as metals, polymers, composites, and ceramics.
2. To understand the latest advancements in automotive materials, including lightweight materials, high-strength alloys, and smart materials.
3. To understand the environmental impact of material selection and manufacturing processes in the automotive industry.
4. To Understand the emerging trends in automotive materials, including electric vehicle materials, light weighting for fuel efficiency, and advancements in battery technology

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## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Introduction to Automotive Materials: Overview of material types: metals, polymers, composites, and ceramics. Criteria for material selection in the automotive industry. Metals in Automotive Applications; Ferrous and non-ferrous alloys. Properties Polymers and Composites, Thermoplastics, thermosetting plastics, and elastomers. Reinforced plastics, carbon fibre composites, and their automotive applications. Applications of steel, aluminium, magnesium, and titanium alloys. Ceramics and Glass. Structural ceramics, advanced ceramics, and their uses in engines and braking systems. Glass materials: properties and applications in automotive glazing. | 9 |
| 2 | Lightweight Materials: Importance of weight reduction in automotive design. Applications of advanced high-strength steels (AHSS), aluminium alloys, and magnesium alloys. High-Performance Materials, Superalloys, titanium alloys, and their applications in high-performance vehicles. Introduction to smart | 9 |

| | | |
|---|---|---|
| | materials and shape memory alloys. Surface Engineering and Coatings Surface treatments, coatings for corrosion resistance, and wear protection. Role of coatings in improving material performance and longevity. Additive Manufacturing and Nanotechnology: Overview of additive manufacturing processes and their applications in the automotive industry. Nanomaterials: properties, synthesis, and applications. | |
| **3** | Environmental Considerations in Material Selection: Life cycle assessment (LCA) of automotive materials. Impact of materials on vehicle emissions and fuel efficiency. Strategies for recycling metals, polymers, and composites. End-of-life vehicle (ELV) recycling and circular economy concepts. Development and application of bio-based and biodegradable materials. Eco-design principles and their implementation in automotive manufacturing. Overview of environmental regulations affecting the automotive industry. Standards for automotive material sustainability and compliance. | **9** |
| **4** | Materials for Electric Vehicles (EVs): Requirements for light weighting and energy efficiency in EVs. Battery materials: lithium-ion, solid-state batteries, and future alternatives. Advanced Materials for Fuel Efficiency: Aerodynamics, lightweight materials, and their role in reducing fuel consumption, Use of composites and advanced alloys in structural components. Smart and Functional Materials: Development of self-healing materials, sensors, and conductive materials for automotive applications. Integration of smart materials in vehicle systems and components. Future Directions in Automotive Materials: Trends in material innovation, sustainability, and manufacturing processes. Research and development opportunities in new materials and technologies. | **9** |

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**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Internal Ex | Evaluate | Analyse | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**Assignment: 20 Marks**

*Students should evaluate and analyze a real-world optimization problem, assess the proposed solutions, provide a conclusion on which solution is most appropriate for the problem, and implement the chosen solution using any specific technique/tool/software/programme.*

***Criteria for evaluation:***

1. ***Problem Definition (K4 - 4 points)***

a. *Clearly defines the real-world optimization problem.*

b. *Examine and identifies relevant contextual factors (constraints, resources, objectives).*

2. ***Problem Analysis (K4 - 4 points)***

a. *Break-down and presents a well-reasoned solution approach.*

b. *Compare and justify the proposed solutions with evidence and logical reasoning.*

3. ***Evaluate (K5 - 4 points)***

a. *Thoroughly evaluate the proposed solutions.*

b. *Compares trade-offs, advantages, and disadvantages.*

c. *Considers feasibility, scalability, and practical implications.*

4. ***Implementation (K5 - 4 points)***

a. *Select the most feasible solution by implementing the proposed solutions/techniques.*

b. *Successfully translates the problem to solution using proposed technique.*

c. *Demonstrates proficiency in solution practices (readability, efficiency, error handling).*

5. ***Conclusion (K4- 2 points, K5 – 2 points)***

a. *Summarizes findings and insights. State which solution is most appropriate for the problem.* ***(K4)***

b. *Reflects critical thinking and informed decision-making.* ***(K5)***

***Scoring:***

1. ***Accomplished (4 points)****: Exceptional analysis, clear implementation, and depth of understanding.*
2. ***Competent (3 points)****: Solid performance with minor areas for improvement.*
3. ***Developing (2 points)****: Adequate effort but lacks depth or clarity.*
4. ***Minimal (1 point)****: Incomplete or significantly flawed.*

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**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br><br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand the fundamental properties of various materials used in automotive manufacturing, such as metals, polymers, composites, and ceramics. | **K2** |
| **CO2** | Understand the latest advancements in automotive materials, including lightweight materials, high-strength alloys, and smart materials. | **K2** |
| **CO3** | Analyze the environmental impact of material selection and manufacturing processes in the automotive industry. | **K4** |
| **CO4** | Evaluate the emerging trends in automotive materials, including electric vehicle materials, light weighting for fuel efficiency, and advancements in battery technology. | **K5** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

## CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | 2 | 1 | - | - | - | - | - | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | - | - | - | - | - | 2 |
| **CO3** | 1 | 2 | - | - | 1 | 3 | 3 | 1 | - | - | - | 1 |
| **CO4** | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | - | - | 3 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Automotive Engineering: Lightweight, Functional, and Novel Materials | Brian Cantor, P. Grant, C. Johnston | CRC Press | 2008 |
| **2** | Automotive Materials Technology | James E. Duffy | Cengage Learning | 2005 |
| **3** | Materials for Automobile Bodies | Geoff Davies | Butterworth-Heinemann | 2012 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Advanced Materials in Automotive Engineering | Jason Rowe | Woodhead Publishing | 2012 |
| **2** | Sustainable Automotive Technologies | Jörg Wellnitz, Karsten Dröder, Bernhard Heinrich | Springer | 2013 |
| **3** | Handbook of Automotive Powertrain and Chassis Design | John Fenton | SAE International | 2000 |
| **4** | Materials for Sustainable Energy Applications: Conversion, Storage, Transmission, and Consumption | David Munoz-Rojas, Xavier Moya | CRC Press | 2016 |
| **5** | Automotive Engineering: Lightweight, Functional, and Novel Materials | Brian Cantor, Patrick Grant, Colin Johnston | CRC Press | 2008 |

| Video Link ID |
|---|
| Structure and analysis of nano materials by Prof. Kaushik Pal<br>https://www.youtube.com/watch?v=vq8uFgTVIT0<br><br>Engineering Materials and Metallurgy"Dr. Vivek Pancholi, IIT Roorkee<br>https://youtu.be/KWmWFs8iIQ4 |

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