Michigan Alliance for Greater Mobility Advancement

Course Title: Steel Bracket Design: Basics of Automotive Mechanical and Machine Component Design and Manufacture

Course Length: 2 Days

Time Online: Participants may be asked to view two or three online videos as a part of homework

Time in Class: 5-6 hours (Lab and Class) per day

Time in Lab: 1 hour

Class Size: Minimum 6 / Maximum 25

Price Per Student: $2,690.00*

Location: Company Site

Course Description:

The objectives of this course are to cover a broad range of topics needed for a basic understanding of how steel and other materials used in automotive industry are selected to perform the functional requirements that they are intended to serve. MAGMA's original title of this course is "Steel Bracket Design". The proposed coursework provides the base knowledge necessary for working with technologies as well as opportunities to obtain more in-depth knowledge and experience in specific skill areas needed at their work.

The main topics of the course cover: Materials and material selection, material characterization (including strength and stiffness considerations), optimum design based on strength (size and thickness) of steel brackets, flanges, joining methodologies including fasteners and welding, manufacturing methodologies including forming (cam piercing, marking hemming, bending, hole punching, deburring, beads, anti-rotation feature, etc.), inspection methodologies (for holes, burrs, etc.), functional design requirements to minimize or prevent corrosion, lightweighting by mass optimization, basics of crash performance, etc. Several case studies will be discussed, including the tire rim example, engine mounting brackets, flange design for rims, exhaust pipe joints, fasteners and rivets for general fastening of panels and different other joining methodologies.

Lab Projects Description:

- Simple hand calculations using basic math for stress and deflection
- Excel sheet for obtaining stress versus strain curves to understand the difference between steel and aluminum materials
- Viewing online videos

* Price based on minimum enrollment, subject to change

Course Learning Objectives:
Participants will be able to:

- Be able to understand different types of loads acting on machine components and subsystems (Statics)
- Gain a basic understanding of material selection for automotive engineering components
- Gain basic knowledge on mechanical and material properties of common engineering materials such as steel, aluminum and other non-metals such as plastics and composites
- Be able to perform simple calculations to determine stress, strain and deformation of components subjected to simple loading conditions
- Be able to understand and do simple design calculations to size members (including linear and cross-sectional dimensions)
- Be able to understand the intricacies and mechanics of various manufacturing methods
- Be able to understand simple inspection methods to detect defects of manufacturing operations
- Be able to understand the failure prevention of components due to environmental conditions such as corrosion

Course Content/Syllabus:
The proposed course is designed to meet over two days (or more), 5 to 6 hours per day including short breaks.

Prerequisites: Entry level knowledge of materials and processes for manufacturing automotive and other industry components; Basic math skills using calculator and/or Excel, basic computer usage for viewing online materials such as case studies and YouTube videos, and any CAD skills will also help in solving simple examples.

Reference Books/Handout Materials:

- Lecture handouts will be distributed one week in advance
- Basic textbook or online materials on Mechanical and Machine Design
- Basic textbook or online materials on Manufacturing Processes

Course Topics and Roadmap:

Day 1 (5 to 6 hours maximum):
1. Engineering Design (1 hour)
    a. Introduction and course review
    b. Design for manufacture and assembly (DFMA)
    c. Design for functional performance (DFP)
    d. Design optimization for size, mass and cost versus maintenance
    e. Design for sustainability (DFS)
    f. Life cycle assessment
    g. Summary, real life examples & discussion
2. Material considerations (1.5 hours)
    a. Material selection guidelines using Ashby charts and ASM standards
    b. Metals (steel and aluminum) versus non-metals (plastics and composites – benefits and limitations:
    c. Current trends and real life examples of material considerations

d. Summary & discussion

3. Basic mechanical physical properties of metals (1.5 hours)
    a. Stress and strain considerations – examples
    b. Rigidity and stiffness – real life examples
    c. Resilience and toughness – real life examples
    d. Stiffness to weight ratio – real life examples
    e. Major metallurgical differences between metals and nonmetals, applications
    f. Summary & discussion
4. Design for Functional Performance – environmental considerations (1 hour)
    a. Corrosion – real life examples
    b. Protection against corrosion – real life examples
    c. Coatings and Non-conductive barrier material – real life examples
    d. Mixed material designs – real life examples
    e. Summery & discussion

Day 2 (5 to 6 hours maximum):

1. Fundamentals of structural connections and interfaces (1.0 hour)
    a. Structural joints: riveted, bolted, welded (case studies)
    b. Simple mechanics of bolted joints (case study of a simple bracket)
    c. Basics of Hertz contact stress at interfaces
    d. Kinematic coupling: Automotive example
2. Design considerations for inserted fasteners (2 hours)
    a. Types of inserts and the key design parameters: retention strength, hardness, thickness, compatible materials, edge, tolerances, etc.
    b. Aligning welded nuts to through holes – examples
    c. Examples of self-locating projection weld nuts
    d. Self-clinching standoff stud and/or nut for thin members
    e. Limitations of welding and clinching connections
    f. Example of tire rim beads, bead locks and weld studs
3. Examples of cost: piece cost and vendor tooling costs (1.5 hours)
    a. Summary of mass optimization for steel brackets design by material removal
    b. Summary of anti-rotation feature in bearings
    c. Examples of formation and control of burr direction
4. Course summary, conclusions and Q&A (0.5 hours)

MAGMA short courses are held on a rolling basis, based on industry demand. Please complete this **short form** to express interest for yourself, or your organizatio

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