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A study on Interdisciplinary Curriculum for Mechanical Engineering

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***Abstract*— This paper describes a study on an interdisciplinary curriculum for mechanical engineering. The interdisciplinary strategy presented in the present research involves departments that haven't typically worked well together to provide learners with capstone design opportunities. Teams of students from the computer and mechanical engineering departments cooperate on completing a capstone design project that gets placements from industry. The method of defining relevant design projects that coordinate with the goals of the mechanical engineering curriculum is comprehensive, as well as the amount of involvement of the industrial partner. To demonstrate the interdisciplinary morality of the design projects and how they fulfil the program's goals and objectives, the automotive sector is examined by the students. Finally, the paper focuses on challenges faced by mechanical engineering students, improve their chances of securing placements and concludes with a model interdisciplinary curriculum**.

***Keywords*— Challenges, Curriculum, Interdisciplinary, Mechanical Engineering, Placements.**

***JEET Category*— Research**

I. INTRODUCTION

THE philosophy behind this interdisciplinary approach is rooted in the recognition that innovation thrives at the crossroads of different domains. By exposing mechanical engineering students to a broader spectrum of knowledge, they are better equipped to address the complex and interconnected problems of the 21st century. In this curriculum, students will engage in a transformative educational journey, one that emphasizes critical thinking, adaptability, and creativity. They will develop the skills necessary to excel in diverse career paths, from traditional mechanical engineering roles to emerging fields like renewable energy, robotics, and sustainable design. This introduction marks the beginning of a transformative educational experience for mechanical engineering students, one that prepares them not only to embrace the challenges of today but also to shape the technologies and solutions of tomorrow. By fostering interdisciplinary collaboration, promoting innovation, and nurturing a holistic understanding of engineering, this curriculum paves the way for mechanical engineers to be the catalysts of progress in an increasingly complex and interconnected world.

According to [1], capstone design courses, where students collaborate in teams to complete a project, are a crucial component of the majority of recognized engineering programmes. Previous studies on the capstone design for mechanical engineering [2–7] revealed how industry was successfully involved in creating and organizing capstone design projects at various schools. Beginning in 2007, the Howard University mechanical engineering department changed into a phase in which senior-year students were involved in the creation of a product to satisfy a desired demand in the aerospace industry. This was done in partnership with several industries. In order to adequately characterize the given challenge, generate concepts, create concept models, do analyses to confirm the problem's limitations and specifications, and eventually create full-scale models of their designs, student teams engaged in competitive activity. A similar collaborative cooperation with Philadelphia-based Boeing Helicopters was established after this method for the capstone design and continued for a further six years until 2012. The titles of design projects that were offered by sponsors and carried out by students between 1989 and 2003[8]. Although the stretcher design course is typically performed in one engineering discipline or in interdisciplinary integration of various engineering departments, it is typically defined as a multidisciplinary challenge. The paper by Ellis [7] provides a review of teaching and student learning in a multi-disciplinary capstone design project involving students from mechanical engineering, architecture, industrial design and building construction. Mechanical engineering is a diverse and fundamental branch of engineering that plays a crucial role in designing, manufacturing, and maintaining various mechanical systems and devices. It forms the

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backbone of many industries, ranging from automotive and aerospace to energy and manufacturing. Despite its broad applications and significance, there has been a concern in recent years regarding the challenges faced by mechanical engineering graduates in securing placements in core industries. This issue has garnered attention and requires a closer examination to understand the underlying reasons. Several factors contribute to the predicament of mechanical engineering graduates not finding placements in core industries, and it is essential to delve into these factors to gain a comprehensive understanding of the situation. This paper will explore some of the key factors that influence this trend, including technological advancements, changing industry demands, and the evolving skillset required for success in the field. It will also discuss potential solutions and strategies that aspiring mechanical engineers can adopt to enhance their employability in core industries to enhance the interdisciplinary curriculum.

II. Challenges

The challenges faced by mechanical engineering students in getting placements in core industries can vary depending on several factors, and it's essential to understand that this issue is not universal and may not apply to all mechanical engineering students or regions. However, there are several common reasons why some mechanical engineering students may struggle to secure placements in core industries:

Economic Conditions: The economic conditions in a particular region or country can significantly impact job opportunities in core industries. During economic downturns or recessions, companies may reduce hiring, affecting placement rates.

Technological Advancements: As industries evolve and become more technologically advanced, there is a growing demand for engineers with expertise in areas like software, electronics, and automation. Mechanical engineering students who lack skills in these areas may face more challenges in securing positions in modern, high-tech industries.

Competition: Mechanical engineering is a highly competitive field, with many graduates vying for a limited number of positions. High competition can make it more challenging for students to secure placements, especially in core industries.

Skills Mismatch: Some mechanical engineering programs may not adequately prepare students for the specific skills and knowledge required in core industries. If the curriculum is outdated or lacks hands-on experience, students may struggle to meet industry demands.

Geographic Location: The availability of core industries can vary by geographic location. Students in areas with fewer core industries may face challenges finding suitable placements unless they are willing to relocate.

Networking and Soft Skills: Building a professional network and possessing strong soft skills, such as communication and teamwork, are essential for securing job placements. Students who neglect these aspects may face difficulties in interviews and networking events.

Internship and Co-op Opportunities: Gaining practical experience through internships and co-op programs can significantly improve a student's chances of securing a job in a core industry. If a student does not have access to these opportunities, it can be more challenging to compete for positions.

Lack of Specialization: Some core industries may require specialized knowledge or certifications that mechanical engineering students do not possess. For example, the aerospace industry may require specific aerospace engineering qualifications.

Changes in Industry Focus: Core industries can change their focus or priorities over time. If an industry shifts away from traditional mechanical engineering applications, it may reduce the number of positions available to mechanical engineering graduates.

III. Improvement

To improve their chances of securing placements in core industries, mechanical engineering students can consider the following strategies:

Stay Informed: Keep abreast of industry trends and developments and adapt your skills and knowledge accordingly.

Build a Strong Network: Attend industry events, join professional organizations, and connect with professionals in your field to build a network that can help with job opportunities.

Gain Relevant Experience: Seek internships, co-op opportunities, or research projects that align with your career goals.

Develop Soft Skills: Work on your communication, teamwork, and problem-solving skills, as these are highly valued by employers.

Consider Further Education: Pursuing advanced degrees or certifications in specialized areas can open up more opportunities in core industries.

Geographic Flexibility: Be willing to consider job opportunities in different geographic locations if your ideal industry is not prominent in your current location.

Consult Career Services: Utilize your university's career services to access job search resources, resume building, interview preparation, and career counseling.

It's important to note that while there may be challenges, many mechanical engineering graduates do find placements in core industries by taking a proactive approach to their education and job search.

IV. Several Reasons for Interdisciplinary Curriculum

Interdisciplinary curriculum is essential for mechanical engineering students for several reasons:

Real-World Problem Solving: Many real-world engineering problems do not neatly fit within the boundaries of a single discipline. Interdisciplinary education equips mechanical engineering students with the knowledge and skills to address complex, multifaceted problems that require collaboration across multiple fields. This prepares them to be more effective problem solvers in their careers.

Integration of Emerging Technologies: In today's rapidly evolving technological landscape, mechanical engineering is increasingly intertwined with other disciplines such as

electronics, materials science, and computer science. An interdisciplinary curriculum allows students to stay up-to-date with emerging technologies and incorporate them into their work.

Innovation: Interdisciplinary education fosters creativity and innovation. Exposure to diverse fields encourages students to think outside the box and come up with novel solutions to complex challenges. This is particularly valuable in industries that require innovation to stay competitive.

Cross-Functional Teams: In the workplace, engineers often collaborate with professionals from various backgrounds, including electrical engineers, computer scientists, biomedical engineers, and more. Interdisciplinary training helps mechanical engineering students communicate and work effectively in cross-functional teams.

Solving Grand Challenges: Many of the world's most pressing challenges, such as climate change, sustainable energy, and healthcare, require interdisciplinary approaches. Mechanical engineers can play a crucial role in addressing these challenges by working alongside experts from other fields.

Diverse Career Opportunities: An interdisciplinary education expands the range of career opportunities available to mechanical engineering graduates. They can work in a wide variety of industries, including aerospace, automotive, biomedical, energy, and more, where interdisciplinary skills are highly valued.

Adaptability: As industries evolve and job requirements change, having a broad skill set acquired through interdisciplinary learning can make mechanical engineers more adaptable to different roles and career transitions.

Global Perspective: Many global challenges, such as sustainable development and resource management, require an understanding of diverse cultures, economies, and political systems. Interdisciplinary education often includes a global perspective, preparing engineers to work in a multicultural and interconnected world.

V. MODEL INTERDISCIPLINARY CURRICULUM

Designing an interdisciplinary curriculum that combines mechanical engineering with computing engineering can produce graduates with a unique skill set highly sought after in various industries. Here's a model interdisciplinary curriculum for a four-year program given in Table I.

TABLE I
MODEL INTERDISCIPLINARY CURRICULUM

Semester I	
Category	Course Name
BSC	Calculus
BSC	Engineering Electromagnetics
BEC	Electrical Circuits for Engineers
BEC	Problem Solving and Programming
BEC	Materials for Engineers
DSC	Foundation for Engineering and Product Design
BSC	Engineering Electromagnetics Practice
BEC	Problem Solving and Programming Practice
HSC	Effective Language and Communication Skills
HSC	NSO/NCC/SSG/NSS
Semester II	
Category	Course Name
BSC	Differential Equations
SEC	Science Elective 1
BEC	Engineering Graphics
ITC	Elementary Data Structures and Logical Thinking
DSC	Sociology of Design
ITC	Design and Manufacturing Lab
PCC	Engineering Mechanics
ITC	Elementary Data Structures and Logical ThinkingPractice
PCC	Mechanics and Materials Practice
HSC	NSO/NCC/SSG/NSS
HSC	Earth, Environment and Design
Semester III	
Category	Course Name
SEC	Science Elective 2
DSC	Systems Thinking for Design
PCC	Engineering Thermodynamics
PCC	Fluid Mechanics and Fluid Machinery
PCC	Mechanics of Materials
PCC	Manufacturing Processes
ITC	Python Programming
HSC	Indian Constitution, Essence of Indian Traditional Knowledge
Semester IV	
Category	Course Name
DSC	Smart Product Design
PCC	Heat Transfer
PCC	Kinematics and Dynamics of Machinery
PCC	Introduction to Machine Learning for mechanical design
PCC	Fluid Mechanics and Heat Transfer Practice
PCC	Machine Learning for Mechanical Design Practice
ITC	Introduction to Operating system
HSC	Human Values and Stress Management
Semester V	
Category	Course Name
ITC	Introduction to Java Programming
DSC	Entrepreneurship and Management Functions
PCC	Design of Machine Elements
PCC	Measurement and Automation thro machine Learning
PCC	Thermal Engineering Practice
PCC	Production Drawing and Inspection Practice

PEC	Professional Elective 1
HSC	Professional Ethics and Organizational Behavior
Semester VI	
Category	Course Name
DSC	Prototyping and Testing
PEC	Professional Elective 2
PEC	Professional Elective 3
OEC	Open Elective 1
OEC	Open Elective 2
HSC	Professional Communication
HSC	Intellectual Property Rights
PCD	Internship
Semester VII	
Category	Course Name
PEC	Professional Elective 4
PEC	Professional Elective 5
OEC	Open Elective 3
PCD	Project Phase I
Semester VIII	
Category	Course Name
PEC	Professional Elective 6
PCD	Project Phase II

BSC- Basic Science Course
SEC- Science Elective Course
BEC- Basic Engineering Course
DSC-Design Course
ITC-IT Skill Course
PCC-Professional Core Course
PEC- Professional Elective Course
OEC-Open Elective Course
HSC-Humanities and Social ScienceCourse
PCD-Professional Career Development

Apart from the model interdisciplinary curriculum, institution must follow the Partial delivery of content by industry experts for mechanical engineering students can offer several benefits like real-world relevance, current industry trends, networking opportunities, problem solving and critical thinking, bridging the gap between theory and practice, motivation and inspiration, practical workshops and projects, by following the above, we can create an industry-specific curriculum that equips mechanical engineering students with the knowledge, skills, and experiences needed to excel in their chosen sector within the field.

VI. CONCLUSION

In conclusion, the implementation of an interdisciplinary curriculum for mechanical engineering students offers a multitude of advantages that extend beyond the traditional boundaries of the field. By incorporating diverse subjects and perspectives, such a curriculum can prepare students for the complex challenges they will encounter in their careers and foster a more holistic and adaptable approach to problem-solving. Here are some key takeaways are broadened skill set, innovation and creativity, real-world relevance, adaptability, career opportunities, addressing global challenges, effective communication, and lifelong learning. In summary, an interdisciplinary curriculum for mechanical engineering students not only enhances their technical expertise but also fosters adaptability, creativity, and a deep understanding of how their field intersects with other disciplines. This holistic approach prepares graduates to tackle complex global challenges and excel in a rapidly evolving technological landscape. As industries become increasingly interconnected, interdisciplinary education is an invaluable investment in the future of mechanical engineering.

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