Sana'a University
Faculty of Engineering
Mechanical Engineering Department
Mechanical Engineering Program

69. Course Plan of Product Design and Development

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Assoc. Prof. Dr. Khalil Al-Hatab	**Office Hours**					
Location& Telephone No.		**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail			10-12			12-2	

II. Course Identification and General Information:

1.	Course Title:	Product Design and Development (Elective).				
2.	Course Number & Code:	ME415.				
3.	Credit Hours:	C.H				TOTAL CR. HRS.
		Th.	Seminar/Tu.	Pr	Tr.	
		2	-	-	-	2
4.	Study level/year at which this course is offered:	Fifth Year - First Semester.				
5.	Pre –requisite (if any):	Machine Design - II (ME336).				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	System of Study:	Semesters.				
10.	Mode of delivery:	Lectures.				
11.	Location of teaching the course:	Mechanical Engineering Department.				

III. Course Description:

This course provides a comprehensive approach of design, development and manufacture of product. The course covers the following topics: introduction to product design and development; product development organization; opportunity identification and product planning; identifying customer needs and product specifications; concept generation; concept

selection and test; product architecture and embodiment design; material selection; design for manufacture; risk, reliability, and safety; quality, robust design, and optimization and product development economics. Students will work in groups to complete one major design project.

IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. An ability to introduce the formal product design cycle; including customer needs assessment, product specification, concept generation and selection.
2. An ability to discuss issues related to product architecture including considerations of design analysis, assembly, maintenance, and operation.
3. An ability to present standards and how they are generated and incorporated in the design process as well as ethical, global, societal issues in the context of design and engineering practice.
4. An ability to present the most common techniques to evaluate manufacturing and assembly efficiency of a design and ways to improve manufacturability of the product and how to determine the tolerances in parts and finished products.
5. An ability to apply system availability and reliability, basic concepts of reliability analysis, fault tree analysis, and failure mode effects and criticality analysis (FMECA) in product design and development.
6. Introduction to optimization theory and decision theory and its application to design.
7. An ability to understand economic analysis and its applications to product design, project funding, and investment.
8. An ability to think creatively and to specify the result of that creativity technically
9. An ability to use industrial design principles appropriately in product development.
10. An ability to advocate effectively for the successful development process in economic as well as technical terms.
11. An ability to manage resources including time, finance, tools, materials and process to assure success for a product development project.

V. Course Content:

- Distribution of Semester Weekly Plan Of course Topics/Items and Activities.

A – Theoretical Aspect:				
Order	**Units/Topics List**	**Sub Topics List**	**Week Due**	**Contact Hours**
1.	Product Design and Development (PDD) Processes	– Course Overview and Project Information – Engineering Design (ED) & Design Levels. – Computer-Aided Engineering (CAD) – Designing to Codes and Standards – Characteristics of Successful PD & Challenges – Product Development Process – Generic Product Development Process – Design Review & Redesign – Societal Considerations in ED – Professionalism and Ethics	1st	2
2.	Product Development Organization (PDO)	– Product Development Organization (PDO) – Choosing an Organization Structure – Effective Team Member – Team Leadership Roles & Team Dynamics – Problem-Solving Tools – Time Management – Understanding and Representing Tasks – Planning and Scheduling	2nd	2
3.	Opportunity Identification & Product Planning	– Structure of Opportunity Identification – Markets and Marketing – Technological Innovation – Opportunity Identification Process – Product Planning Process	3rd	2

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4.	Identifying Customer Needs & Product Specifications	– Types of Design Information & Sources – Identifying Customer Needs & Requirements – Establishing the Engineering Characteristics – Quality Function Deployment – Product Specification – Establishing Target Specifications – Setting the Final Specifications	4th	2
5.	Concept Generation	– Introduction to Creative Thinking – Creative Thinking Methods – Creative Methods for Design – Functional Decomposition and Synthesis – Morphological Methods – TRIZ: Theory of Inventive Problem Solving – The Activity of Concept Generation	5th	2
6.	Concept Selection & Testing	– Decision Making – Evaluation Processes – Concept Screening & Scoring using: • Pugh Chart • Weighted Decision Matrix • Analytic Hierarchy Process (AHP) – Concept testing	6th	2
7.	Product Architecture & Embodiment Design	– Define Product Architecture – Implications of the Architecture – Steps in Developing Product Architecture – Configuration & Parametric Design – Dimensions and Tolerances – Industrial Design – Human Factors Design	7th	2

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		– Life-Cycle Design – Design for X (DFX) – Prototyping and Testing		
8.	Mid-Term Exam	The First Sixth Chapters	8th	2
9.	Product Architecture & Embodiment Design	– Define Product Architecture – Implications of the Architecture – Steps in Developing Product Architecture – Configuration & Parametric Design – Dimensions and Tolerances – Industrial Design – Human Factors Design – Life-Cycle Design – Design for X (DFX) – Prototyping and Testing	9th	2
10.	Materials Selection	– Performance Requirements of Materials – Materials Selection Process – Material Properties information sources – Cost of Materials – Methods of Materials Selection – Material Performance Indices – Materials Selection with Decision Matrices – Selection with Computer-Aided Databases – Design with Materials	10th	2
11.	Design for Manufacturing	– Role of Manufacturing in Design – Manufacturing Functions & Processes – Manufacturing Process Selection – Design for Manufacture (DFM)	11th ,12th	4

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		– Design for Assembly (DFA) – Design for Disassembly (DFDA) – Role of Standardization in DFMA – Mistake-Proofing – Early Estimation of Manufacturing Cost – DFMA Guidelines		
12.	Risk, Reliability, and Safety	– Probabilistic Approach to Design – Reliability Theory – Design for Reliability – Failure Mode and Effects Analysis (FMEA) – Fault Tree Analysis – Defects and Failure Modes – Design for Safety	13th	2
13.	Quality, Robust Design, and Optimization	– The Concept of Total Quality – Quality Control and Assurance – Quality Improvement & Process Capability – Taguchi Method – Robust Design – Design for Experiments (DOE) – Robust Design Process – Optimization Methods – Design Optimization	14th	2
14.	Product Development Economics	– Elements of Economics Analysis – Economics Analysis Processes – Carrying out Qualitative Analysis	15th	2
15.	Final Exam	All the Chapters	16th	2
Number of Weeks /and Units Per Semester			**16**	**32**

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VI. Teaching strategies of the course:

- Active Lectures,
- Project,
- Tutorials,
- Cad Software,
- Interactive Class Discussions,
- Exercises and Homework,
- Problem Based Learning.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	N/A	N/A	1st	N/A
2.	Homework 1	a1, a2, a3, b1, b2, b3, c1, c2, c3	2nd	0.5
3.	Homework 2	a1, a2, a3, b1, b2, b3, c1, c2,c3,	3rd	0.5
4.	Homework 3	a1, a2, a3, b1, b2, b3, c1,c2, c3	4th	0.5
5.	Homework 4	a1, a2, a3, b1, b2, b3, c1,c2, c3	5th	0.5
6.	Homework 5	a1, a2, a3, b1, b2, b3, c1,c2, c3	6th	0.5
7.	Homework 6-7	a1, a2, a3, b1, b2, b3, c1,c2, c3	7th - 8th	1.5
8.	Homework 8	a1, a2, a3, b1, b2, b3, c1,c2, c3	9th	0.5
9.	Homework 9-10	a1, a2, a3, b1, b2, b3, c1,c2, c3	10th -11th	1.5
10.	Homework 11	a1, a2, a3, b1, b2, b3, c1,c2, c3	12th	1
11.	Homework 12	a1, a2, a3, b1, b2, b3, c1,c2, c3	13th	1
12.	Homework 13	a1, a2, a3, b1, b2, b3, c1,c2, c3	14th	1
13.	Homework 14	a1, a2, a3, b1, b2, b3, c1,c2, c3	15th	1
Total				**10**

VIII. Schedule of Assessment Tasks for Students During the Semester:

Assessment	Type of Assessment Tasks	Week Due	Mark	Proportion of Final Assessment
1.	Homework 1 to Homework 14	2nd to 15th	10	10%

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2.	Project	Presentations 1, 2, 3, 4	3rd, 6th, 9th, 12th	4	20	20%
		Final Presentation	14th	4		
		Reports 1, 2, 3, 4	3rd, 6th, 9th, 12th	4		
		Final report	14th	8		
3.	Quizzes 1, 2 ,3		4th ,10th,13th	5		5%
4.	Mid-Term Exam		8th	15		15%
5.	Final Exam		16th	50		50%
Total				**100**		**100%**

IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. Ulrich, K.T. and Eppringer, S.D., 2012, Product Design and Development, 5th Edition, Irwin McGraw-Hill, Inc.
2. George E. Dieter, Linda C. Schmidt, 2013, Engineering Design, 5th Edition, McGraw-Hill, Inc.

2- Essential References.

1. Haik Y., Shahin T., 2011, Engineering Design Process, 2nd Edition, Cengage Learning.
2. Otto K., Wood K., 2000. Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Prentice Hall.
3. Mital A., Desai A., Subramanian A., Mital A., 2014, Product Development: A Structured Approach to Consumer Product Development, Design, and Manufacture, 2nd Elsevier Inc.
4. Angus, R.B., Gundersen, N.R., Cullinane, T.P., Planning, Performing, and Controlling Projects, 3rd Edition, Prentice Hall.
5. M F Ashby and K Johnson, 2003. Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann.

3- Electronic Materials and Web Sites *etc*.

- CAD Software packages

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I. Course Policies:	
1	**Class Attendance:** - The student should be attending not less than 75% of total contact hours of the subject, otherwise he will not able to take exam and be considerd as an exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic.
2	**Tardy:** - For lateness in attending the class, the student will be initially notified. If he repeates late in attending class he will be considered absent.
3	**Exam Attendance/Punctuality:** - The student should attend the exam on time. He is permitted to attend the exam half one hour from exam beginning, after that he/she will not be permitted to take exam and he/she is considered absent in the exam.
4	**Assignments & Projects:** - In general one assignment is given after each chapter of a course. The student should submit the assignment on time, mostly one week after giving the assignment
5	**Cheating**: - For cheating in exam, the student is considered as failure. In case the cheating is repeated three times during study the student will be disengaged from the Faculty
6	**Plagiarism**: Plagiarism is the attending of the student the exam of a course instead of other student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Affair Council of the university.
7	**Other policies:** - The mobile phone is not allowable to be used during class lecture. It must be switched off, otherwise the student will be ordered to leave the lecture room. - The mobile phone is not allowed to be taken during the examination time. - Lecture notes and assignments may be given directly to students using soft or hard copy.

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