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

Course Specification of Machine Design - II

I. Course Identification and General Information:

1.	Course Title:	Machine Design – II.				
2.	Course Code & Number:	ME336.				
3.	Credit Hours:	C.H				TOTAL CR. HRS.
		Th.	Seminar/Tu	Pr	Tr.	
		2	2	-	-	3
4.	Study level/ semester at which this course is offered:	Fourth year - First semester				
5.	Pre –requisite (if any):	Mechanics of Machines (ME121) and Machine Design - I (ME235)				
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.	Location of teaching the course:	Mechanical Engineering Department				
10.	Prepared By:	Prof. Dr.Eng. Mohammed Ahmed Al-Bukahiti Associate Prof. Dr. Khalil Al-Hatab				
11.	Date of Approval					

II. Course Description:

This course will continue the development of a systematic design-problem solving and extends the machine element design approach introduced in Machine Design-I course. It will focus on mathematical modelling for design applications, stress analysis and force flow through components and assemblies, belt and chain drive design, rolling element bearing selection, gears types and design, brake design and clutch design. It will provide an opportunity to explore these ideas in terms of practical applications.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

	III. Alignments of the Course Intended learning outcomes (CILOs) of the course	Referenced PILOs
a1	Explain the basics of machine design, including the design process, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements.	A1.
a2	Recognize the procedures and principles of design toward the selection of engineering materials and design of basic machine elements.	A2.
a3	Recognize the use of mathematical modeling and computer software for selection and designing of belts, bearing, gears, clutch and brake.	A4.
b1	Investigate the design processes, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements to make a full design journal bearing, gears, clutch, brake and belt.	B1.
b2	Analyze the open-ended design problems.	B2.
c1	Apply the computer software (SOLIDWORKS, EXCEL, MATLAB, …etc.) within the engineering design workflow and apply this to a range of design analysis problems.	C1.
c2	Perform the technical reports that includes analysis briefs, graphically express basic machine elements, describe the context and significance of the design, and stress analysis of machine components and the procedures / methods used to solve them and apply the results for the services.	C2.
c3	Implement design standards in the design, selection, assessment and specification of machine components to satisfy safety, reliability and function of the machine for desired applications.	C3.
d1	Cooperate effectively as a part of group projects.	D1.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

d2	Review the literature for a real-world problem/project, use databases, and evaluate information and evidence from various sources.	D4.
d3	Effectively communicate and present design ideas.	D5.

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
a1-	Explain the basics of machine design, including the design process, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements.	Lectures, Tutorials, Software Packages, Projects	Examinations, Homework, Presentations
a2-	Recognize the procedures and principles of design toward the selection of engineering materials and design of basic machine elements.	Lectures, Tutorials, Software Packages, Projects	Examinations, Homework, Presentations, Individual and Group Project Reports.
a3-	Recognize the use of mathematical modeling and computer software for selection and designing of belts, bearing, gears, clutch and brake.	Lectures, Tutorials, Software Packages (ANSYS, SOLIDWORKS & ABAQUS), Projects.	Examinations, Homework, Presentations, Individual and Group Project Reports

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Investigate the design processes, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements to make a full design journal bearing, gears, clutch, brake and belt.	Lectures, Tutorials, Lectures, Real-World Problem, Projects	Examinations, Homework, Presentations, Individual and Group Project Reports
b2- Analyze the open-ended design problems.	Lectures, Tutorials, Lectures, Real-World Problem, Projects	Examinations, Homework, Presentations, Individual and Group Project Reports

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1- Apply the computer softwares (SOLIDWORKS, EXCEL, MATLAB, …etc.) within the engineering design workflow and apply this to a range of design analysis problems.	Real-World Problem, Software Packages, Projects	Examinations, Presentations, Individual and Group Project Reports.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad
2. Assoc. Prof. Dr. Khalil Al-Hatab				

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

c2-	Perform the technical reports that includes analysis briefs, graphically express basic machine elements, describe the context and significance of the design, and stress analysis of machine components and the procedures / methods used to solve them and apply the results for the services.	Real-World Problem, Projects	Examinations, Presentations, Individual and Group Project Reports.
c3-	Implement design standards in the design, selection, assessment and specification of machine components to satisfy safety, reliability and function of the machine for desired applications.	Lectures, Real-World Problem, Projects	Examinations, Presentations, Individual and Group Project Reports.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
d1-	Cooperate effectively as a part of group projects.	Real-World Problem, Projects	Presentations, Reports
d2-	Review the literature for a real-world problem/project, use databases, and evaluate information and evidence from various sources.	Real-World Problem, Projects	Presentations, Reports
d3-	Effectively communicate and present design ideas.	Real-World Problem, Projects.	Presentations, Reports

Prepared by Prof. Dr. 1. Mohammed Al-Bukahiti	Head of Department Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad
2. Assoc. Prof. Dr. Khalil Al-Hatab			Rector of Sana'a University Prof. Dr. Al-Qassim Mohammed Abbas	

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction to Mechanical Engineering Design	a1, b1, b2, c1, c3	– Course Overview and Introduction – Mechanical Engineering Design – Design with Materials – Manufacturing Considerations – Brief Review of Stress Analysis	1	2
2.	Rolling-Contact Bearing	a1, b1, b2,c3	– Bearing Types – Bearing Life – Bearing Load Life at Rated Reliability – Combined Radial and Thrust Loading – Variable Loading – Selection of Roller Bearings – Design Assessment – Lubrication – Mounting and Enclosure	1	2
3.	Journal Bearings	a1, b1, b2, c3	– Types of Lubrication – Viscosity – Petroff's Equation – Stable Lubrication – Thick-Film Lubrication	2	4

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

			– Hydrodynamic Theory – Design Considerations – The Relations of the Variables – Steady-State Conditions – Clearance, Pressure, Loads and Materials – Bearing Types		
4.	General Review of Gears		– Nomenclature – Fundamentals – Contact Ratio – Interference – Tooth Systems – Gear Types – Gear Trains – Force Analysis	1	2
5.	Spur & Helical Gears	a1, a2, a3, b1, b2, c3	– Lewis and Buckingham equations – Design of Gears using AGMA Procedure – Important Design Factors – Design of a Gear Mesh – Check for Wear	2	4
6.	Mid-Term Exam	a1, a2, a3, b1, b2, c1, c2, c3	The First Five Chapters	1	2
7.	Bevel & Worm Gears	a1, a2, a3, b1, b2, c3	– Bevel-Gear Stresses and Strengths – Straight-Bevel Gear Analysis	1	2

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

			– Design of a Straight-Bevel Gear Mesh – Worm Gearing — AGMA Equation – Worm-Gear Analysis – Designing a Worm-Gear Mesh		
8.	Clutches, Brakes, Couplings, and Flywheels	a1, a2, a3, b1, b2, c3	– Static Analysis of Clutches and Brakes – Internal Expanding Rim Clutches and Brakes – External Contracting Rim Clutches and Brakes – Band-Type Clutches and Brakes – Frictional-Contact Axial Clutches – Disk Brakes – Cone Clutches and Brakes – Energy Considerations – Temperature Rise – Friction Materials – Miscellaneous Clutches and Couplings – Flywheels	4	8
9.	Flexible Mechanical Elements	a1, a2, a3, b1, b2, c3	– Belts – Flat- and Round-Belt Drives – V Belts – Timing Belts – Roller Chain	2	4

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

10.	Final Exam	a1,a2,a3, b1,b2, c1,c2, c3	All the Chapters	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B – Tutorial Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction to Mechanical Engineering Design	a1, b1, b2, c1, c3	– Course Overview and Introduction – Mechanical Engineering Design – Design with Materials – Manufacturing Considerations – Brief Review of Stress Analysis	1	2
2.	Rolling-Contact Bearing	a1, b1, b2,c3	– Bearing Types – Bearing Life – Bearing Load Life at Rated Reliability – Combined Radial and Thrust Loading – Variable Loading – Selection of Roller Bearings – Design Assessment – Lubrication – Mounting and Enclosure	1	2

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

3.	Journal Bearings	a1, b1, b2, c3	– Types of Lubrication – Viscosity – Petroff's Equation – Stable Lubrication – Thick-Film Lubrication – Hydrodynamic Theory – Design Considerations – The Relations of the Variables – Steady-State Conditions – Clearance, Pressure, Loads and Materials – Bearing Types	2	4
4.	General Review of Gears		– Nomenclature – Fundamentals – Contact Ratio – Interference – Tooth Systems – Gear Types – Gear Trains – Force Analysis	1	2
5.	Spur & Helical Gears	a1, a2, a3, b1, b2, c3	– Lewis and Buckingham equations – Design of Gears using AGMA Procedure – Important Design Factors – Design of a Gear Mesh – Check for Wear	2	4

Prepared by Prof. Dr. 1. Mohammed Al-Bukahiti	Head of Department Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

6.	Bevel & Worm Gears	a1, a2, a3, b1, b2, c3	– Bevel-Gear Stresses and Strengths – Straight-Bevel Gear Analysis – Design of a Straight-Bevel Gear Mesh – Worm Gearing — AGMA Equation – Worm-Gear Analysis – Designing a Worm-Gear Mesh	1	2
7.	Clutches, Brakes, Couplings, and Flywheels	a1, a2, a3, b1, b2, c3	– Static Analysis of Clutches and Brakes – Internal Expanding Rim Clutches and Brakes – External Contracting Rim Clutches and Brakes – Band-Type Clutches and Brakes – Frictional-Contact Axial Clutches – Disk Brakes – Cone Clutches and Brakes – Energy Considerations – Temperature Rise – Friction Materials – Miscellaneous Clutches and Couplings – Flywheels	4	8
8.	Flexible Mechanical Elements	a1, a2, a3, b1, b2, c3	– Belts – Flat- and Round-Belt Drives – V Belts	2	4

Prepared by Prof. Dr. 1. Mohammed Al-Bukahiti	Head of Department Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

			– Timing Belts – Roller Chain		
Number of Weeks /and Units Per Semester				**14**	**28**

V. Teaching strategies of the course:

- Active Lectures,
- Project
- Tutorials
- Software Packages (Solidworks, Excel, Matlab, …Etc.)
- Interactive Class Discussions
- Exercises and Home Works
- Problem Based Learning

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Homework 1	a1, b1, b2,c1,c3	2nd	1.25
2	Homework 2	a1, b1, b2, c3	3rd	1.25
3	Homework 3	a1, b1, b2, c3	4th	1.25
4	Homework 4	a1, a2, a3, b1, b2, c3	5th	1.25
5	Homework 5	a1, a2, a3, b1, b2, c3	6th	1.25
6	Homework 6	a1, a2, a3, b1, b2, c3	7th	1.25
7	Homework 7	a1, a2, a3, b1, b2, c3	9th	1.25
8	Homework 8	a1, a2, a3, b1, b2, c3	10th	1.25
9	Homework 9	a1, a2, a3, b1, b2, c3	11th	1.25

Prepared by
Prof. Dr.
1. Mohammed Al-Bukahiti

Head of Department
Asst. Prof. Dr. Eng.
Hamoud Al-Nahari

Quality Assurance Unit
Assoc. Prof. Dr.
Mohammad Algorafi

Dean of the Faculty
Prof. Dr. Mohammed
AL-Bukhaiti

Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

10	Homework 10	a1, a2, a3, b1, b2, c3	12th	1.25
11	Homework 11	a1, a2, a3, b1, b2, c3	13th	1.25
12	Homework 12	a1, a2, a3, b1, b2, c3	14th	1.25
Total				**15**

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Homework 1 to Homework 12	2nd to 14th	15	10%	a1, a2, a3, b1, b2, c3
2	Real problem Presentation	5th to 11th	10	6.67.%	a1, a2, a3, b1, b2,c1, c2, c3, d1, d2,d3
3	Project report and presentation	4th, 5th, 6th ,11th, 14th	15	10%	a1, a2, a3, b1, b2,c1, c2, c3, d1, d2,d3
4	Quiz 1- Quiz 3	4th ,7th,11th	10	6.67%	a1,a2,a3,b1,b2,c1,c2,c3
5	Mid-Term Exam	8th	20	13.33%	a1,a2,a3,b1,b2,c1,c2,c3
6	Final exam	15th	75	50%	a1,a2,a3,b1,b2,c1,c2,c3
Total			**150**	**100%**	

VIII. Learning Resources:

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

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

1. R.S. Khurmi and J.K. Gupta, 2008, A Textbook of Machine Design, S. CHAND.
2. Budynas, RG & Nisbett, JK, 2015, Shigley's Mechanical Engineering Design (SI units), 10th Ed, McGraw Hill, New York.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

	3. Course notes and power point presentations
2- Essential References.	
	1. Juvinall, RC & Marshek, KM 2017, Fundamentals of machine component design, 6th ed., John Wiley & Sons, Hoboken, NJ. 2. Hamrock, B.J., Schmid, S.R., Jacobson, B., 2014, Fundamentals of Machine Elements (SI units), 3rd ed., CRC Press (Taylor & Francis Group, LLC). 3. Norton, R. L., 2012, Machine Design: An Integrated Approach, 3rd ed., Pearson Education. 4. Shahin Nudehi, John Steffen, 2017, Analysis of Machine Elements Using SOLIDWORKS Simulation 2017, SDC Publications. 5. Ansel C. Ugural, 2015, Mechanical Design of Machine Components, 2nd ed., CRC Press (Taylor & Francis Group, LLC).
3- Electronic Materials and Web Sites *etc*.	
	1- Software packages: ANSIS & SOLIDWORKS

IX. Course Policies:

1.	**Class Attendance:** -A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic
2.	**Tardy:** - For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:** - A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.
4.	**Assignments & Projects:**

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

	- The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating**: - For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6.	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed 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 Council Affair of the university.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Asst. Prof. Dr. Eng. Hamoud A. Al-Nahari**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad
2. Assoc. Prof. Dr. Khalil Al-Hatab				

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

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

Course Plan of Machine Design - II

I. Information about Faculty Member Responsible for the Course:

Name of Faculty Member	Prof. Dr. Mohammed Ahmed Al-Bukhaiti Associate Prof. Dr. Khalil Al-Hatab	**Office Hours**					
Location& Telephone No.	University of Sana'a, Faculty of Engineering, +00967 777161416	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	m.albukhati@eng-su.edu.ye m.albukhaiti@gmail.com alhxxxx@yahoo.cox		10-12			12-2	

II. Course Identification and General Information:

1-	Course Title:	Machine Design – II.				
2-	Course Number & Code:	ME336.				
3-	Credit Hours:	C.H				TOTAL CR. HRS.
		Th.	Seminar/Tu.	Pr.	Tr.	
		2	2	-	-	3
4-	Study level/year at which this course is offered:	Fourth Year - First Semester.				
5-	Pre –requisite (if any):	Mechanics of Machines (ME121) and Machine Design - I (ME235)				
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 and Tutorials.				
11-	Location of teaching the course:	Mechanical Engineering Department.				

Prepared by Prof. Dr. 1. Mohammed Al-Bukahiti	Head of Department Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

III. Course Description:

This course will continue the development of a systematic design-problem solving and extends the machine element design approach introduced in Machine Design-I course. It will focus on mathematical modelling for design applications, stress analysis and force flow through components and assemblies, belt and chain drive design, rolling element bearing selection, gears types and design, brake design and clutch design. It will provide an opportunity to explore these ideas in terms of practical applications.

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

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

1. Explain the basics of machine design, including the design process, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements.
2. Recognize the procedures and principles of design toward the selection of engineering materials and design of basic machine elements.
3. Recognize the use of mathematical modeling and computer software for selection and designing of belts, bearing, gears, clutch and brake.
4. Investigate the design processes, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements to make a full design journal bearing, gears, clutch, brake and belt.
5. Analyze the open-ended design problems.
6. Apply the computer software (SOLIDWORKS, EXCEL, MATLAB, …etc.) within the engineering design workflow and apply this to a range of design analysis problems.
7. Perform the technical reports that includes analysis briefs, graphically express basic machine elements, describe the context and significance of the design, and stress analysis of machine components and the procedures / methods used to solve them and apply the results for the services.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

8. Implement design standards in the design, selection, assessment and specification of machine components to satisfy safety, reliability and function of the machine for desired applications.
9. Cooperate effectively as a part of group projects.
10. Review the literature for a real-world problem/project, use databases, and evaluate information and evidence from various sources.
11. Effectively communicate and present design ideas.

V. Course Content:

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

A – Theoretical Aspect:

Order	Topics List	Sub -Topics List	Week Due	Contact Hours
1.	Introduction to Mechanical Engineering Design	– Course Overview and Introduction – Mechanical Engineering Design – Design with Materials – Manufacturing Considerations – Brief Review of Stress Analysis	1st	2
2.	Rolling-Contact Bearing	– Bearing Types – Bearing Life – Bearing Load Life at Rated Reliability – Combined Radial and Thrust Loading – Variable Loading – Selection of Roller Bearings – Design Assessment – Lubrication	2nd	2

Prepared by
Prof. Dr.
1. Mohammed Al-Bukahiti

Head of Department
Asst. Prof. Dr. Eng.
Hamoud Al-Nahari

Quality Assurance Unit
Assoc. Prof. Dr.
Mohammad Algorafi

Dean of the Faculty
Prof. Dr. Mohammed
AL-Bukhaiti

Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

		– Mounting and Enclosure		
3.	Journal Bearings	– Types of Lubrication – Viscosity – Petroff's Equation – Stable Lubrication – Thick-Film Lubrication – Hydrodynamic Theory – Design Considerations – The Relations of the Variables – Steady-State Conditions – Clearance, Pressure, Loads and Materials – Bearing Types	3rd, 4th	4
4.	General Review of Gears	– Nomenclature – Fundamentals – Contact Ratio – Interference – Tooth Systems – Gear Types – Gear Trains – Force Analysis	5th	2
5.	Spur & Helical Gears	– Lewis and Buckingham equations – Design of Gears using AGMA Procedure – Important Design Factors	6th, 7th	4

Prepared by Prof. Dr. 1. Mohammed Al-Bukahiti	Head of Department Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

		– Design of a Gear Mesh – Check for Wear		
6.	Mid-Term Exam	The First Five Chapters	8th	2
7.	Bevel & Worm Gears	– Bevel-Gear Stresses and Strengths – Straight-Bevel Gear Analysis – Design of a Straight-Bevel Gear Mesh – Worm Gearing — AGMA Equation – Worm-Gear Analysis – Designing a Worm-Gear Mesh	9th	2
8.	Clutches, Brakes, Couplings, and Flywheels	– Static Analysis of Clutches and Brakes – Internal Expanding Rim Clutches and Brakes – External Contracting Rim Clutches and Brakes – Band-Type Clutches and Brakes – Frictional-Contact Axial Clutches – Disk Brakes – Cone Clutches and Brakes – Energy Considerations – Temperature Rise – Friction Materials – Miscellaneous Clutches and Couplings – Flywheels	10th, 11th, 12th, 13th	8

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

9.	Flexible Mechanical Elements	– Belts – Flat- and Round-Belt Drives – V Belts – Timing Belts – Roller Chain	14th, 15th	4
10.	Final Exam	All the Chapters	16th	2
Number of Weeks /and Units Per Semester			**16**	**32**

C – Tutorial Aspect:

Order	Topics List	Sub -Topics List	Week Due	Contact Hours
1.	Introduction to Mechanical Engineering Design	– Course Overview and Introduction – Mechanical Engineering Design – Design with Materials – Manufacturing Considerations – Brief Review of Stress Analysis	1st	2
2.	Rolling-Contact Bearing	– Bearing Types – Bearing Life – Bearing Load Life at Rated Reliability – Combined Radial and Thrust Loading – Variable Loading – Selection of Roller Bearings – Design Assessment – Lubrication – Mounting and Enclosure	2nd	2
3.	Journal Bearings	– Types of Lubrication	3rd, 4th	4

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

		– Viscosity – Petroff's Equation – Stable Lubrication – Thick-Film Lubrication – Hydrodynamic Theory – Design Considerations – The Relations of the Variables – Steady-State Conditions – Clearance, Pressure, Loads and Materials – Bearing Types		
4.	General Review of Gears	– Nomenclature – Fundamentals – Contact Ratio – Interference – Tooth Systems – Gear Types – Gear Trains – Force Analysis	5^{th}	2
5.	Spur & Helical Gears	– Lewis and Buckingham equations – Design of Gears using AGMA Procedure – Important Design Factors – Design of a Gear Mesh – Check for Wear	6^{th}, 7^{th}	4
6.	Bevel & Worm Gears	– Bevel-Gear Stresses and Strengths – Straight-Bevel Gear Analysis – Design of a Straight-Bevel Gear Mesh – Worm Gearing — AGMA Equation – Worm-Gear Analysis – Designing a Worm-Gear Mesh	8^{th}	2

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

7.	Clutches, Brakes, Couplings, and Flywheels	– Static Analysis of Clutches and Brakes – Internal Expanding Rim Clutches and Brakes – External Contracting Rim Clutches and Brakes – Band-Type Clutches and Brakes – Frictional-Contact Axial Clutches – Disk Brakes – Cone Clutches and Brakes – Energy Considerations – Temperature Rise – Friction Materials – Miscellaneous Clutches and Couplings – Flywheels	9th, 10th, 11th, 12th	8
8.	Flexible Mechanical Elements	– Belts – Flat- and Round-Belt Drives – V Belts – Timing Belts – Roller Chain	13th, 14th	4
Number of Weeks /and Units Per Semester			**14**	**28**

VI. Teaching strategies of the course:

- Active Lectures,
- Project
- Tutorials
- Software Packages (Solidworks, Excel, Matlab, …Etc.)
- Interactive Class Discussions
- Exercises and Home Works
- Problem Based Learning

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Homework 1	a1, b1, b2,c1,c3	2nd	1.25
2	Homework 2	a1, b1, b2, c3	3rd	1.25
3	Homework 3	a1, b1, b2, c3	4th	1.25
4	Homework 4	a1, a2, a3, b1, b2, c3	5th	1.25
5	Homework 5	a1, a2, a3, b1, b2, c3	6th	1.25
6	Homework 6	a1, a2, a3, b1, b2, c3	7th	1.25
7	Homework 7	a1, a2, a3, b1, b2, c3	9th	1.25
8	Homework 8	a1, a2, a3, b1, b2, c3	10th	1.25
9	Homework 9	a1, a2, a3, b1, b2, c3	11th	1.25
11	Homework 11	a1, a2, a3, b1, b2, c3	13th	1.25
12	Homework 12	a1, a2, a3, b1, b2, c3	14th	1.25
Total				**15**

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 12	2nd to 14th	15	10%
2	Real problem Presentation	5th to 11th	10	6.67.%
3	Project report and presentation	4th, 5th, 6th ,11th, 14th	15	10%
4	Quiz 1- Quiz 3	4th ,7th,11th	15	10%
5	Mid-Term Exam	8th	20	13.33%
6	Final exam	15th	75	50%
Total			**150**	**100%**

Prepared by
Prof. Dr.
1. Mohammed Al-Bukahiti

Head of Department
Asst. Prof. Dr. Eng.
Hamoud Al-Nahari

Quality Assurance Unit
Assoc. Prof. Dr.
Mohammad Algorafi

Dean of the Faculty
Prof. Dr. Mohammed
AL-Bukhaiti

Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

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. R.S. Khurmi and J.K. Gupta, 2008, A Textbook of Machine Design, S. CHAND.
2. Budynas, RG & Nisbett, JK, 2015, Shigley's Mechanical Engineering Design (SI units) Ed, McGraw Hill, New York.
3. Course notes and power point presentations

2- Essential References.

1. Juvinall, RC & Marshek, KM 2017, Fundamentals of machine component design, 6th ed., John Wiley & Sons, Hoboken, NJ.
2. Hamrock, B.J., Schmid, S.R., Jacobson, B., 2014, Fundamentals of Machine Elements (SI units), 3rd ed., CRC Press (Taylor & Francis Group, LLC).
3. Norton, R. L., 2012, Machine Design: An Integrated Approach, 3rd ed., Pearson Education.
4. Shahin Nudehi, John Steffen, 2017, Analysis of Machine Elements Using SOLIDWORKS Simulation 2017, SDC Publications.
5. Ansel C. Ugural, 2015, Mechanical Design of Machine Components, 2nd ed., CRC Press (Taylor & Francis Group, LLC)

3- Electronic Materials and Web Sites *etc*.

Software packages: ANSIS & SolidWorks

X. Course Policies:

1.	**Class Attendance:** -A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic
2.	**Tardy:** - For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

3.	**Exam Attendance/Punctuality:** - A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating**: - For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6.	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed 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 Council Affair of the university.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. Lecture notes and assignments my given directly to students using soft or hard copy

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
Prof. Dr. 1. Mohammed Al-Bukahiti	Asst. Prof. Dr. Eng. Hamoud Al-Nahari	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad

2. Assoc. Prof. Dr. Khalil Al-Hatab

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas