37.Course Specification of Design of Machine Elements

I.Course Identification and General Information:						
.1	Course Title:	Design of Machine Elements.				
.2	Course Code & Number:	MT210.				
.3	Credit hours:	C.H				TOTAL CR. HRS
		Th.	Seminar	Pr.	Tu.	
		2	-	2	-	3
.4	Study level/ semester at which this course is offered:	Third Year - Second Semester.				
.5	Pre – requisite (if any):	Statics, Dynamics, Properties and Strength of Materials, Theory of Machines, Manufacturing Process.				
.6	Co – requisite (if any):	Industrial Automation (CAD-CAM).				
7.	Program (s) in which the course is offered:	Mechatronics Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	Location of teaching the course:	Mechatronics Engineering Department.				
10.	Prepared By:	Prof. Dr. Mohammed Ahmed Al-Bukhaiti.				
11.	Date of Approval:					

II.Course Description:

Machine Design is the art of developing ideas for the construction of machines and expressing those ideas in the form of plans and drawings. This course will integrate the knowledge and principles learned in statics, dynamics, properties and strength of materials into the analysis, selection and design process of specific machine elements. Students will learn the fundamentals of the design process, simple stresses in machine elements, static failure theories, variable stresses in machine parts, metal fits and tolerances, element design: Power screws, bolted joints, keys, pins, splines, shafts, couplings, gears, belts, bearings, and design projects.

III.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Define scientific principles and apply them to the practice of mechanical engineering design.	A1

a2.	Classify the principal stresses, under static and cyclic loadings, acting on a critical point of the machine element and identify basic sizes, fits, and tolerances of the mating parts through design process.	A2
a3.	Depict material and manufacturing methods for mechanical components based on strength, rigidity, fatigue, and reliability considerations.	A3
a4.	Describe the problem-solving skills and confidence necessary to educate themselves continually through their careers.	A2, A3
b1.	Analyze basic and principal stresses under conditions of static and cyclic loadings act on machine elements, and design machine members subjected to axial forces, binding moments, and torsional moments.	B1, B2
b2.	Design screwed, bolted, keyed, pins, and splined joints, shafts carrying out various combinations of gears, belt pulleys, spur gears, belts, journal bearings, roller bearings, and flywheels to insure safe operation.	B3, B4
b3.	Analyze design projects in machine elements.	B6
c1.	Apply fundamentals of stress analysis, theories of failures under steady and variable loadings, in applications involving design of machine elements such as power screws, shafts, couplings, belt drives, gears, bearings, etc.	C1
c2.	Choose different analytical techniques and Computer-Aided-Design tools to solve machine design problems, as well as to perform design projects.	C2
c3.	Demonstrate design codes and standards to develop, analyze, and specify common machine elements such as screws, fasteners, shafts, couplings, gears, bearings, etc.	C5
c4.	Practice the ability to design shrink fitted assemblies, screws, key and spline joints, shafts, couplings, belts and belt drives, gears, and bearings.	C2, C5
d1.	Co-operate well as a part of team and communicate effectively through written and oral skills.	D1
d2.	Assess to professional quality design project report and make oral presentations as well as written reports for his/her projects.	D2
d3.	Review the given problems of machine design and complete projects using appropriate computational tools.	D6, D7

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

Define scientific principles and **a1**. them to the practice of apply engineering design. mechanical	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
Classify the principal stresses, **a2**. static and cyclic loadings, under a critical point of the acting on element and identify basic machine of the and tolerances sizes, fits, through design mating parts process.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
Depict material and manufacturing **a3**. methods for mechanical based on strength, components and reliability rigidity, fatigue, considerations.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
Describe the problem-solving **a4**. and confidence necessary skills educate themselves continually to through their careers.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching Strategies**	**Assessment Strategies**
Analyze basic and principal **b1**. under conditions of stresses loadings static and cyclic and act on machine elements, design machine members subjected to axial forces, binding moments, and torsional moments.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
Design screwed, bolted, keyed, **b2**. and splined joints, shafts pins, carrying out various combinations of gears, belt pulleys, spur gears,	• Lectures. • Presentations. • Tutorials.	• Written Assignments. • Written Exams. • Home Work.

bearings, roller belts, journal flywheels to insure bearings, and safe operation.	• Group Projects.	• Projects. • Class Attendance and Participation.
Analyze design projects in **b3**. machine elements.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.

(C) 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 fundamentals of stress analysis, theories of failures steady and variable under applications loadings, in machine involving design of elements such as power screws, shafts, couplings, belt drives, gears, bearings, etc.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
c2. Choose different analytical techniques and Computer-Design tools to solve Aided-as machine design problems, well as to perform design projects.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
c3. Demonstrate design codes and to develop, standards and specify analyze, elements common machine such as screws, fasteners, shafts, couplings, gears, etc. bearings,	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
c4. Practice the ability to design fitted assemblies, shrink key and spline joints, screws, couplings, belts and belt shafts, gears, and bearings. drives,	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching Strategies**	**Assessment Strategies**
Co-operate well as a part of communicate and team through written and oral effectively skills. **d1**.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
Assess to professional quality project report and make design oral presentations as well as written reports for his/her projects. **d2.**	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.
Review the given problems of machine design and complete projects using appropriate computational tools. **d3**.	• Lectures. • Presentations. • Tutorials. • Group Projects.	• Written Assignments. • Written Exams. • Home Work. • Projects. • Class Attendance and Participation.

IV.Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction General Procedure of Machine Design.	a1,a2, b1,b2, c1,c2 d1,d2.	Design-Definition, General procedure of machine design, Design considerations, Materials and their properties, Manufacturing considerations in machine design.	1	2
2.	Design for Static Strength:	a1,a2,a3, b1,b2,b3	Static loads, Tensile stress and strain, Compressive stress and strain, Shear	2	4

	(Stresses in Machine Elements).	c1,c2,c3, d1,d2,d3.	stress and strain, Bearing stress, Working stress, Factor of safety, Torsional and bending stresses, Principal stresses, Theories of failure under static load.		
3.	Design for Fatigue Strength: (Variable Stresses in Machine Elements).	a1,a2,a3, b1,b2,b3, c1,c2,c3, d1,d2,d3.	Introduction, Fatigue and endurance limit, Effect of loading, surface finish, and size on endurance limit, Endurance limit and ultimate tensile strength relation, Safety factor for fatigue loading, combined steady and variable stresses.	2	4
4.	Screws and Screwed Joints Joints and Attachments.	a1,a2,a3,a4, b1,b2,b3, c1,c2,c3,c4 d1,d2,d3.	Standard dimensions of screw threads, Stresses in screwed joints, Bolt strength, Bolted joints. Keys, Splines, Pins	2	4
5.	Mid-Term Exam.	,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4.	The First 4 Chapters.	1	2
5.	Design of Shafts.	a1,a2,a3,a4, b1,b2,b3, c1,c2,c3,c4 d1,d2,d3.	Types of shafts, Shaft materials, Types of loading on shafts, Stresses in shafts, Design of shafts under various loading.	1	2
6.	Coupling Design.	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.	Shaft coupling, Types of shaft couplings, Design sleeve coupling, Design of clamp coupling, Design of rigid coupling.	1	2
7.	Belt and Belt Drives.	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.	Introduction, Types of belts, Belts materials, Selection of belts, Flat belt design, V-belt design.	1	2

8.	Gears.	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.	Types of gears, Nomenclature of gears, Loading, Force analysis-Spur gearing, Force analysis-Helical gearing, Design of spur gear teeth-Lewis equation, Dynamic and wear tooth loads	2	4
9.	Journal Bearings.	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.	Types of sliding contact bearings, Lubricants, Properties of lubricants, Lubrication regimes, Design procedure for journal bearings.	1	2
10.	Rolling Contact Bearings.	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.	Types of rolling contact bearings, Basic static load rating, Basic dynamic load rating, Equivalent static load, Life of bearing, Equivalent dynamic load of rolling contact bearings.	1	2
11.	Final Exam.	,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4.	All the Chapters.	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes
1.	**Tutorial (1) for the following subtopics**: General procedure of machine design, Design considerations, Materials and their properties, Manufacturing considerations in machine design, Code and standards. **Computer-Aided-Design Lab (SOLID-WORK)**	1	1 h for Tutorial (1) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
2.	**Tutorial (2) for the following subtopics**: Static loads, Tensile stress and strain, Compressive stress and strain, Shear stress	2	2 h for Tutorial (2)	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4

	and strain, Bearing stress, Working stress, Factor of safety, Torsional and bending stresses, Principal stresses, Theories of failure under static load. **Computer-Aided-Design Lab (SOLI-WORK)**		2 h for Lab exercises and project design	d1,d2,d3.
3.	**Tutorial (3) for the following subtopics**: Introduction, Fatigue and endurance limit, Effect of loading, surface finish, and size on endurance limit, Endurance limit and ultimate tensile strength relation, Safety factor for fatigue loading, combined steady and variable stresses. **Computer-Aided-Design Lab (SOLID-WORK)**	2	2 h for Tutorial (3) 2 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
4.	**Tutorial (4) for the following subtopics**: Standard dimensions of screw threads, Stresses in screwed joints, Bolt strength, Bolted joints, Keys, Splines, Pins. **Computer-Aided-Design Lab (SOLID-WORK)**	2	2 h for Tutorial (4) 2 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
5.	**Tutorial (5) for the following subtopics**: Types of shafts, Shaft materials, Types of loading on shafts, Stresses in shafts, Design of shafts under various loading. **Computer-Aided-Design Lab (SOLID-WORK)**	1	1 h for Tutorial (5) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
6.	**Tutorial (6) for the following subtopics**: Shaft coupling, Types of shaft couplings, Design sleeve coupling, Design of clamp coupling, Design of rigid coupling. **Computer-Aided-Design Lab SOLID-WORK)**	1	1 h for Tutorial (6) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
7.	**Tutorial (7) for the following subtopics**: Introduction, Types of belts, Belts materials, Selection of belts, Flat belt design, V-belt design. **Computer-Aided-Design Lab (SOLID-WORK)**	1	1 h for Tutorial (7) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
8.	**Tutorial (8) for the following subtopics**:	2	2 h for Tutorial (8)	a1,a2,a3,a4 b1,b2,b3

	Loading, Force Analysis-Spur gearing, Force Analysis-Helical gearing, Design of spur gear teeth-Lewis equation, Dynamic and wear tooth loads, Design of helical spur gear teeth. **Computer-Aided-Design Lab (SOLID-WORK)**		2 h for Lab exercises and project design	c1,c2,c3,c4 d1,d2,d3.
9.	**Tutorial (9) for the following subtopics**: Types of sliding contact bearings, Lubricants, Properties of lubricants, Lubrication regimes, Design procedure for journal bearings. **Computer-Aided-Design Lab (SOLID-WORK)**	1	1 h for Tutorial (9) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
10.	**Tutorial (10) for the following subtopics**: Basic static load rating, Basic dynamic load rating, Equivalent static load, Life of bearing, Equivalent dynamic load of rolling contact bearings**.** **Computer-Aided-Design Lab (SOLID-WORK)**	1	1 h for Tutorial (10) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
Number of Weeks /and Units Per Semester		**14**	**28**	

V.Teaching strategies of the course:

- Class Lectures.
- Tutorials.
- Computer-Aided-Design Lab (SOLID-WORK).
- Exercises and Homework.
- Small Group Working in Design Projects.
- Interactive Class Discussion and Presentations.
- Electronic Library (search for new topics).

VI.Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Home works.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4, d1, d2, d3.	14	5

2.	Design of various machine elements using SOLID-WORK.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4 d1, d2, d3.	10	5
3.	Implementation of a practical project on the design of machine components.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4 d1, d2, d3.	12	5
4.	Project report.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4 d1, d2, d3.	14	5
Total				**20**

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.	Project report and presentation (single/group), Homework, implementation of practical project.	15th	20	13%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
2.	Mid-Term Written Exams (1).	8th	15	10%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
3.	Mid-Term Exam Written Exam (2).	12th	15	10%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
4.	Final Exam (practical).	15th	10	7%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
5.	Final Exam (theoretical).	16th	90	60%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
	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, 2005, A textbook of Machine Design, 14th Edition, S. CHAND & COMPNY LTD.

2- Shigley, J.E., Budynas, R.G., and Nisbett, J.K., 2011, Mechanical Engineering 9th Edition, McGraw Hill. Design,

2- Essential References.

1- Juvinall, R. C. and Marshek, K. M., 2005, Fundamentals of Machine Component Design, 4th Edition. New York: John Willy & Sons.

2- Hamrock, B. J., Jacobson, B. and Schmid, S. R., 2006, Fundamentals of Machine Elements, 6th Edition, Mc-Graw Hill.

3- Norton, R. L., 2003, Machine Design: An Integrated Approach, 3rd Edition, Prentice Hall.

4- Mott, R. L., 2004, Machine Elements in Mechanical Design, 4th Edition, Prentice Hall.

Spotts, M. F. and Shoup, T. E., 2004, Design of Machine Elements, 8th Edition, Prentice Halln.

5- K.M. Emara, A. Abouel-Kasem, 2005, Lecture in Machine Design.

3- Electronic Materials and Web Sites *etc*.

1. H. G Patil, 2011, Machine Design Data Hand Book, I.K. International Publishing House Pvt., Limited.
2. V K Jadon, Suresh Verma, 2009, Machine Design Data Book, 2nd Edition, I.K. International Publishing House Pvt. Limited.
3. SOLID-WORK Tutorial Guides

1. Related projects and subjects using the available resources of the Faculty's Electronic Library.
2. http://www.skf.com/uk/products/bearings-units-housings/ball-bearings/deep-groove-ball-bearings/single-row-deep-groove-ball-bearings/brary.
3. http://www.skf.com/uk/products/bearings-units-housings/ball-bearings/deep-groove-ball-bearings/single-row-deep-groove-ball-bearings/

IX.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 considered as an exam failure. If the student is absent due to illness, he/she should bring the approved statement from university Clinic.
2.	**Tardy:** For late in attending the class, the student will be initially notified. If he comes late in attending class again, he will consider as 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 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 considered as failure. Case the cheating repeated three times during study the student will disengage 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 allowed to be used during class lecture. It must be closed, otherwise the student will ask to leave the lecture room - The mobile phone is not allowed to be taken with in class during the examination. - Lecture notes and assignments may be 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. Head of Mechatronics Engineering Department: Assoc. Prof. Dr. Abdul-Malik Momin.
	Deputy Rector for Academic Affairs Assoc. Prof. Dr. Ibrahim AlMutaa. Assoc. Prof. Dr. Ahmed Mujahed. Asst. Prof. Dr. Munaser Alsubari.

Head of the Department Assoc. Prof. Dr. Abdul-Malik Momin	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	Rector of Sana'a University Prof. Dr. Al-Qassim Mohammed Abbas

Head of the Department Assoc. Prof. Dr. Abdul-Malik Momin	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	Rector of Sana'a University Prof. Dr. Al-Qassim Mohammed Abbas

Template for Course Plan of Design of Machine Elements

I.Information about Faculty Member Responsible for the Course:							
Name of Faculty Member	Prof.Dr. Mohammed Ahmed Al-Bukhaiti	**Office Hours**					
Location& Telephone No.	Sana'a University, Faculty of Engineering, +00967 777161416	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	m.albukhati@eng-su.edu.ye m.albukhaiti@gmail.com			12-2pm			

II.Course Identification and General Information:						
1.	Course Title:	Design of Machine Elements.				
2.	Course Number & Code:	MT210.				
3.	Credit hours:	C.H				Total Cr.Hrs.
		Th.	Seminar	Pr.	Tu.	
		2	-	2	-	3
4.	Study level/year at which this course is offered:	Third Year - Second Semester.				
5.	Pre –requisite (if any):	Statics, Dynamics, Properties and Strength of Materials, Theory of Machines, Manufacturing Process.				
6.	Co –requisite (if any):	Industrial Automation (CAD-CAM).				
7.	Program (s) in which the course is offered	Mechatronics Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	System of Study:	Semesters.				
10.	Mode of delivery:	Lectures and Practical Work.				
11.	Location of teaching the course:	Mechatronics Engineering Department.				

III.Course Description:

Machine Design is the art of developing ideas for the construction of machines and expressing those ideas in the form of plans and drawings. This course will integrate the knowledge and principles learned in statics, dynamics, properties and strength of materials into the analysis, selection and design process of specific machine elements. Students will learn the fundamentals of the design process, simple stresses in machine elements, static failure theories, variable stresses in machine parts, metal fits and tolerances, element design: Power screws, bolted joints, keys, pins, splines, shafts, couplings, gears, belts, bearings, and design projects.

IV.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Define scientific principles and apply them to the practice of mechanical engineering design.	A1
a2.	Classify the principal stresses, under static and cyclic loadings, acting on a critical point of the machine element and identify basic sizes, fits, and tolerances of the mating parts through design process.	A2
a3.	Depict material and manufacturing methods for mechanical components based on strength, rigidity, fatigue, and reliability considerations.	A3
a4.	Describe the problem-solving skills and confidence necessary to educate themselves continually through their careers.	A2, A3
b1.	Analyze basic and principal stresses under conditions of static and cyclic loadings act on machine elements, and design machine members subjected to axial forces, binding moments, and torsional moments.	B1, B2
b2.	Design screwed, bolted, keyed, pins, and splined joints, shafts carrying out various combinations of gears, belt pulleys, spur gears, belts, journal bearings, roller bearings, and flywheels to insure safe operation.	B3, B4
b3.	Analyze design projects in machine elements.	B6
c1.	Apply fundamentals of stress analysis, theories of failures under steady and variable loadings, in applications involving design of machine elements such as power screws, shafts, couplings, belt drives, gears, bearings, etc.	C1
c2.	Choose different analytical techniques and Computer-Aided-Design tools to solve machine design problems, as well as to perform design projects.	C2
c3.	Demonstrate design codes and standards to develop, analyze, and specify common machine elements such as screws, fasteners, shafts, couplings, gears, bearings, etc.	C5

c4.	Practice the ability to design shrink fitted assemblies, screws, key and spline joints, shafts, couplings, belts and belt drives, gears, and bearings.	C2, C5
d1.	Co-operate well as a part of team and communicate effectively through written and oral skills.	D1
d2.	Assess to professional quality design project report and make oral presentations as well as written reports for his/her projects.	D2
d3.	Review the given problems of machine design and complete projects using appropriate computational tools.	D6, D7

V.Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction General Procedure of Machine Design.	Design-Definition, General procedure of machine design, Design considerations, Materials and their properties, Manufacturing considerations in machine design.	1	2
2.	Design for Static Strength: (Stresses in Machine Elements).	Static loads, Tensile stress and strain, Compressive stress and strain, Shear stress and strain, Bearing stress, Working stress, Factor of safety, Torsional and bending stresses, Principal stresses, Theories of failure under static load.	2,3	4
3.	Design for Fatigue Strength: (Variable Stresses in Machine Elements).	Introduction, Fatigue and endurance limit, Effect of loading, surface finish, and size on endurance limit, Endurance limit and ultimate tensile strength relation, Safety factor for fatigue loading, combined steady and variable stresses.	4,5	4
4.	Screws and Screwed Joints Joints and Attachments.	Standard dimensions of screw threads, Stresses in screwed joints, Bolt strength, Bolted joints. Keys, Splines, Pins	6,7	4

5.	Mid-Term Exam.	The First 4 Chapters.	8	2
6.	Design of Shafts.	Types of shafts, Shaft materials, Types of loading on shafts, Stresses in shafts, Design of shafts under various loading.	9	2
7.	Coupling Design.	Shaft coupling, Types of shaft couplings, Design sleeve coupling, Design of clamp coupling, Design of rigid coupling.	10	2
8.	Belt and Belt Drives.	Introduction, Types of belts, Belts materials, Selection of belts, Flat belt design, V-belt design.	11	2
9.	Gears.	Types of gears, Nomenclature of gears, Loading, Force analysis-Spur gearing, Force analysis-Helical gearing, Design of spur gear teeth-Lewis equation, Dynamic and wear tooth loads	12,13	4
10.	Journal Bearings.	Types of sliding contact bearings, Lubricants, Properties of lubricants, Lubrication regimes, Design procedure for journal bearings.	14	2
11.	Rolling Contact Bearings.	Types of rolling contact bearings, Basic static load rating, Basic dynamic load rating, Equivalent static load, Life of bearing, Equivalent dynamic load of rolling contact bearings.	15	2
12.	Final Exam.	All the Chapters.	16	2
Number of Weeks /and Units Per Semester			**16**	**32**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes
1.	**Tutorial (1) for the following subtopics:**	1	1 h for Tutorial (1)	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4

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	General procedure of machine design, Design considerations, Materials and their properties, Manufacturing considerations in machine design, Code and standards. **Computer-Aided-Design Lab (SOLID-WORK)**		1 h for Lab exercises and project design	d1,d2,d3.
2.	**Tutorial (2) for the following subtopics**: Static loads, Tensile stress and strain, Compressive stress and strain, Shear stress and strain, Bearing stress, Working stress, Factor of safety, Torsional and bending stresses, Principal stresses, Theories of failure under static load. **Computer-Aided-Design Lab (SOLI-WORK)**	2,3	2 h for Tutorial (2) 2 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
3.	**Tutorial (3) for the following subtopics**: Introduction, Fatigue and endurance limit, Effect of loading, surface finish, and size on endurance limit, Endurance limit and ultimate tensile strength relation, Safety factor for fatigue loading, combined steady and variable stresses. **Computer-Aided-Design Lab (SOLID-WORK)**	4,5	2 h for Tutorial (3) 2 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
4.	**Tutorial (4) for the following subtopics**: Standard dimensions of screw threads, Stresses in screwed joints, Bolt strength, Bolted joints, Keys, Splines, Pins. **Computer-Aided-Design Lab (SOLID-WORK)**	6,7	2 h for Tutorial (4) 2 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
5.	**Tutorial (5) for the following subtopics**: Types of shafts, Shaft materials, Types of loading on shafts, Stresses	8	1 h for Tutorial (5)	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.

	in shafts, Design of shafts under various loading. **Computer-Aided-Design Lab (SOLID-WORK)**		1 h for Lab exercises and project design	
6.	**Tutorial (6) for the following subtopics**: Shaft coupling, Types of shaft couplings, Design sleeve coupling, Design of clamp coupling, Design of rigid coupling. **Computer-Aided-Design Lab SOLID-WORK)**	9	1 h for Tutorial (6) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
7.	**Tutorial (7) for the following subtopics**: Introduction, Types of belts, Belts materials, Selection of belts, Flat belt design, V-belt design. **Computer-Aided-Design Lab (SOLID-WORK)**	10	1 h for Tutorial (7) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
8.	**Tutorial (8) for the following subtopics**: Loading, Force analysis-Spur gearing, Force analysis-Helical gearing, Design of spur gear teeth-Lewis equation, Dynamic and wear tooth loads, Design of helical spur gear teeth. **Computer-Aided-Design Lab (SOLID-WORK)**	11,12	2 h for Tutorial (8) 2 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
9.	**Tutorial (9) for the following subtopics**: Types of sliding contact bearings, Lubricants, Properties of lubricants, Lubrication regimes, Design procedure for journal bearings. **Computer-Aided-Design Lab (SOLID-WORK)**	13	1 h for Tutorial (9) 1 h for Lab exercises and project design	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.
10.	**Tutorial (10) for the following subtopics**: Basic static load rating, Basic dynamic load rating, Equivalent	14	1 h for Tutorial (10)	a1,a2,a3,a4 b1,b2,b3 c1,c2,c3,c4 d1,d2,d3.

	static load, Life of bearing, Equivalent dynamic load of rolling contact bearings. **Computer-Aided-Design Lab (SOLID-WORK)**		1 h for Lab exercises and project design	
Number of Weeks /and Units Per Semester		**14**	**28**	

VI.Teaching strategies of the course:

- Class lectures.
- Tutorials.
- Computer-Aided-Design Lab (SOLID-WORK).
- Exercises and Homework.
- Small Group Working in Design Projects.
- Interactive Class Discussion and Presentations.
- Electronic Library (search for new topics).

VII.Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Home works.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4, d1, d2, d3.	14	5
2.	Design of various machine elements using SOLID-WORK.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4 d1, d2, d3.	10	5
3.	Implementation of a practical project on the design of machine components.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4 d1, d2, d3.	12	5
4.	Project report.	a1, a2, a3, a4, b1, b2, b3, c1, c2, c3, c4 d1, d2, d3.	14	5
Total				**20**

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

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Project report and resentation.	15th	20	13%	a1, a2, a3, a4

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	(single/group), Homework, implementation of practical project.				b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
2.	Mid-Term Written Exams (1).	8th	15	10%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
3.	Mid-Term Written Exam (2).	12th	15	10%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
4.	Final Exam (practical).	15th	10	7%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
5.	Final Exam (theoretical).	16th	90	60%	a1, a2, a3, a4 b1, b2, b3 c1, c2, c3, c4 d1, d2, d3.
	Total		**150**	**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. R.S. Khurmi and J.K. Gupta, 2005, A textbook of Machine Design, 14th Edition, S. CHAND & COMPNY LTD.
2. Shigley, J.E., Budynas, R.G., and Nisbett, J.K., 2011, Mechanical Engineering Design, 9th Edition, McGraw Hill.

2- Essential References.

1. Juvinall, R. C. and Marshek, K. M., 2005, Fundamentals of Machine Component Design, 4th Edition. New York: John Willy & Sons.
2. Hamrock, B. J., Jacobson, B. and Schmid, S. R., 2006, Fundamentals of Machine Elements, 6th Edition, Mc-Graw Hill.
3. Norton, R. L., 2003, Machine Design: An Integrated Approach, 3rd Edition, Prentice Hall.
4. Mott, R. L., 2004, Machine Elements in Mechanical Design, 4th Edition, Prentice Hall.
5. Spotts, M. F. and Shoup, T. E., 2004, Design of Machine Elements, 8th Edition, Prentice Halln.

	6. K.M. Emara, A. Abouel-Kasem, 2005, Lecture in Machine Design.
	3- Electronic Materials and Web Sites *etc*.
	1. H. G Patil, 2011, Machine Design Data Hand Book, I.K. International Publishing House Pvt., Limited. 2. V K Jadon, Suresh Verma, 2009, Machine Design Data Book, 2nd Edition, I.K. International Publishing House Pvt. Limited. 3. SOLID-WORK Tutorial Guides
	1. Related projects and subjects using the available resources of the Faculty's Electronic Library. 2. http://www.skf.com/uk/products/bearings-units-housings/ball-bearings/deep-groove-ball-bearings/single-row-deep-groove-ball-bearings/brary. 3. http://www.skf.com/uk/products/bearings-units-housings/ball-bearings/deep-groove-ball-bearings/single-row-deep-groove-ball-bearings/

X.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 considered as an exam failure. If the student is absent due to illness, he/she should bring the approved statement from university Clinic.
2.	**Tardy:** For late in attending the class, the student will be initially notified. If he comes late in attending class again, he will consider as 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 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 considered as failure. Case the cheating repeated three times during study the student will disengage 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 allowed to be used during class lecture. It must be closed, otherwise the student will ask to leave the lecture room - The mobile phone is not allowed to be taken with in class during the examination. - Lecture notes and assignments may be given directly to students using soft or hard copy.