Course Syllabus

1. **Course number and name**
   ME 471 Mechanical Vibrations
2. **Credits and contact hours**
   (3+0) 3 credit hours, 3 contact hours

3. **Instructor's or course coordinator's name**
   Dr. Mohammad Bani-Khaled

4. **Textbook information**
   Mechanical Vibrations by S. S. Rao, Prentice Hall

   a. **Other supplemental materials**
      Instructor's Notes

5. **Specific course information**
   a. **Catalog description**

Dynamic behavior of mechanical systems under vibration. It will discuss the theory and applications of mechanical vibrations including damped and undamped vibrations for discreet and continuous systems.

   b. **Prerequisites or co-requisites**

Prerequisite: ME 211 Dynamics ; CEE 203 Advanced Engineering Math I

   c. **The course is:**
      Required in the Mechanical Engineering program.

6. **Specific goals for the course**
   a. **Course outcomes:**
      After completion of the course, students are expected to be able to

1. Students realize the disasters that could occur due to vibrations, and realize his professional responsibilities against this kind of problems.
2. Students learn to derive the equations of motions of vibrating systems using their knowledge in dynamics and mathematics.
3. Students learn to derive lumped parameter models that represent real systems and obtain the vibration characteristics of such systems.
4. Students learn to use damping and vibration absorbers as means for vibration attenuation.
5. Students are aware of the need to engage in life-long learning and training to handle real life systems that require more complex modelling and analysis that are beyond the scope of this course.
6. Students will come out of the course armed with basic engineering tools to understand measure and analyze vibration and make recommendations on how to overcome vibrations problem.

   a. **The following student outcomes are addressed by the course:**

SO-(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

SO-(f) an understanding of professional and ethical responsibility.

SO-(pc-1) apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations); to model, analyze, design, and realize physical systems, components or processes.

SO-(pc-3) prepare students to work professionally in mechanical systems

7. Brief list of topics to be covered

1. What is vibrations and why it is important
2. Fundamentals of Vibrations, Equivalent Systems and derivation of Equations of Motion, Energy Methods
3. Free Vibrations of mass-spring systems, including damped and undamped SDOF systems.
4. Forced vibrations of damped and undamped SDOF systems.
5. Oscillating base and force transmission.
6. Rotating unbalance and relative motion.
7. Vibration under general forcing conditions.
8. Free vibration of 2DOF systems and coordinate coupling 2DOF.
9. Forced vibration of 2DOF system and vibration absorbers.
10. Vibration of multi DOF systems.
11. Vibration of continuous systems.
12. Vibration measurements

8. Weekly plan.

Week No.	Lecture	Topic	Method of Delivery
1	1	Introduction	Lecture
	2	Introduction: periodic motion	Lecture
	3	Energy method to derive the equations of motion	Lecture
2	4	Free Vibrations/ Undamped Single Degree of Freedom Systems	Lecture
	5	Free Vibrations/ Undamped Single Degree of Freedom Systems	Lecture
	6	Forced Vibrations/ Undamped Single Degree of Freedom Systems	Lecture
3	7	Free Vibrations/ Damped Single Degree of Freedom Systems	Lecture
	8	Free Vibrations/ Damped Single Degree of Freedom Systems	Lecture

	9	Damping in Structural and Mechanical Systems, Viscous, Structural, Coulomb Damping.	Lecture
4	10	Forced Vibrations/ Damped Single Degree of Freedom Systems	Lecture
	11	Forced Vibrations/ Damped Single Degree of Freedom Systems	Lecture
	12	Response of Damped SDOF Systems to General Excitations	Lecture
5	13	Rotating unbalance	Lecture
	14	Base motion	Lecture
	15	Self-Excitation and Stability Analysis	Lecture
6	16	Solutions Using Laplace Transforms	Lecture
	17	Isolation of Instruments and Foundations, Motion Sensing Instrumentation	Lecture
	18	Vibration's measurements and data acquisition systems	Lecture
7	19	Application and demonstrations	Exam
	20	First Exam	Lecture
	21	Two Degree of Freedom Systems	Lecture
8	22	2 DOF, Free-Vibration Analysis of an Undamped System	Lecture
	23	Eigenvalues, Mode Shapes, Modal Frequencies	Lecture
	24	Torsional System	Lecture
9	25	Coordinate Coupling and Principal Coordinates	Lecture
	26	Forced Vibrations of 2 DOF system.	Lecture
	27	Forced Vibrations of 2 DOF system.	Lecture
10	28	Self-Excitation and Stability Analysis	Lecture
	29	Multi DOF system.	Lecture
	30	Multi DOF system.	Lecture
11	31	Generalized Coordinates and Generalized Forces	Lecture
	32	Example	Lecture
	33	Lagrange's Equations	Lecture
12	34	Lagrange's Equations	Lecture
	35	Numerical solutions of multi dof systems.	Lecture

	36	Example	Lecture
13	37	Continuous Systems	Lecture
	38	Transverse Vibration of a String or Cable	Lecture
	39	Transverse Vibration of a String or Cable	Lecture
14	40	Longitudinal Vibration of a Bar or Rod	Lecture
	41	Longitudinal Vibration of a Bar or Rod	Lecture
	42	Torsional Vibration of a Shaft or Rod	Lecture
15	43	Lateral Vibration of Beams	Lecture
	44	Lateral Vibration of Beams	Lecture
	45	Final Exam	Lecture

9. Grade distribution

Assessment	Grade	Date
- First Exam	20%	Fifth Week
- Second Exam	20%	10th Week
- Assignments	10%	
- Final Examination	50%	16th Week

* Make-up exams will be offered for valid reasons. It may be different from regular exams in content and format.