Academic Course Description

BHARATH UNIVERSITY
Faculty of Engineering and Technology
Department of Mechanical Engineering
BME401 – DYNAMICS OF MACHINES
Fourth Semester, 2015-16 (Even Semester)

Course (catalog) description

- To understand the method of static force analysis and dynamic force analysis of mechanisms.
- To study the undesirable effects of unbalances in rotors and engines.

Compulsory/Elective course **:** Compulsory

Credit & contact hours : 4 & 60

Course Coordinator : Mr.Golden Ranjith Nimal

Instructors :

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
R.Karthikeyan	II-A	JR001		karthikeyan.mech@ bharathuniv.ac.in	9.00 - 9.50 AM
G.Anbazhagan	II-B	JR002		anbazhagan..mech@ bharathuniv.ac.in	9.50-10.40 AM
R.Sabarish	II-C	JR003		sabarish.mech@ bharathuniv.ac.in	11.40 -12.30 PM
Jose anand vino V	II-D	JR004		anandvinovj258@gmail.com	10.50 - 11.40 AM
R.Hariharan	II-E	SK001		hariharan.mech@ bharathuniv.ac.in	9.00 - 9.50 AM

Relationship to other courses:

Pre –requisites **:** Mathematics I & II

Assumed knowledge : To understand the method of static force analysis and dynamic force analysis of mechanisms.To study the undesirable effects of unbalances in rotors and engines.

Following courses : Machine Design, Advanced Vibration, Vibration control & Monitoring

Syllabus Contents

UNIT I FORCE ANALYSIS OF MECHANISM 12

Static, Inertia and combined force analysis- Graphical and analytical method- Slider crank mechanism and four bar mechanism. Turning moment diagram and flywheel-Applications in engine, Punching presses.

UNIT II BALANCING 12

Static and dynamic balancing-Balancing of rotating masses- Balancing of several masses in different planes. Primary and secondary unbalanced forces of reciprocating parts-Balancing of in line engines- Firing order-Balancing of 'V' and 'W' engines.

UNIT III FREE VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEMS 12

Fundamentals of vibrations-Undammed free vibrations of single d.o.f systems–Derivation & solution of differential equation-Torsional Vibrations-single rotor- Equivalent stiffness of spring combinations-Bifilar, Trifilar suspensions-Compound pendulum-Types of damping-Damped free vibrations of single d.o.f-over, critical, under damped-Damping coefficient - Critical damping coefficient-Logarithmic decrement

UNIT IV FORCED VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEMS 12

Forced vibrations with-Constant harmonic excitation-Rotating & Reciprocating unbalance-Excitation of the support-Energy dissipated by damping-Forced vibrations with coulomb, viscous damping-Vibration Isolation and Transmissibility- Vibration Absorbers

UNIT V CRITICAL SPEEDS AND SHAFTS WITH ROTORS 12

Lateral vibration of beams - Whirling speed of shaft - Shafts with two & three rotors-Geared system.
Dunkerly's method for different types of beams & shaft with several loads.

TOTAL 45 HOURS

TEXT BOOKS:

1. R.S.Khurmi-Theory of Machines-S.Chand Publications.
2. S.S.Rattan-Theory of Machines- Tata McGraw Hill, 2005.

REFERENCES:

1. Rao.J.S. and Dukkipatti, Mechanism and Machines Theory, 2nd Edition-Wiley Eastern Ltd, 1992.
2. Groover.G.K. Mechanical Vibrations- Nemchand & Bros., 2001.
3. Singh.V.P. Mechanical Vibrations-Dhanpatrai & co (p) Ltd, 2005.
4. royalmechanicalbuzz.blogspot.com/.../theory-of-machines-by-rs-khurmi...

Computer usage:

Professional component

General	-	0%
Basic Sciences	-	0%
Engineering sciences & Technical arts	-	0%
Professional subject	-	100%

Broad area: Dynamics, Vibration Analysis in machines

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1	February 2nd week	Session 1 to 14	2 Periods
2	Cycle Test-2	March 2nd week	Session 15 to 28	2 Periods
3	Model Test	April 3rd week	Session 1 to 45	3 Hrs
5	University Examination	TBA	All sessions / Units	3 Hrs.
1	Cycle Test-1	February 2nd week	Session 1 to 14	2 Periods

Mapping of Instructional Objectives with Program Outcome

Student Outcomes (SOs) from Criterion 3 covered by this Course	Correlates to program outcome		
	H	**M**	**L**
1. Upon completion of this course, the Students can able to predict the force analysis in Mechanisms	a,c,l	b	f,g,h,I,j,k,
2. Learn about the mechanical system and related vibration issues.	a,c,l	b	f,g,h,i
3. Can be able to solve mechanical system problem.	a	b,c	
4. Understand static and dynamic balancing	a,c	b	f,g,h,i
5. Understand the application of degrees of freedom and vibrations	a,c,l	b	
6. Understand critical speed of shafts	a,c,l	b	f,g,h,i

H: high correlation, M: medium correlation, L: low correlation

Draft Lecture Schedule

S.NO	Topics	Problem solving (Yes/No)	Text / Chapter
UNIT I FORCE ANALYSIS OF MECHANISM			
1.	Static Force Analysis	No	**T1 & R2**
2.	Four bar mechanism showing external and constraint forces	Yes	
3.	Free-body diagram	No	
4.	Equilibrium of three-force member	Yes	
5.	Graphical method	No	
6.	Static force analysis with friction	Yes	
7.	Inertia force analysis with friction	Yes	
8.	Free Body diagram of slider	Yes	
9.	Gear force Analysis	Yes	
10.	three force members- related problems	Yes	
11.	Turning moment diagram and flywheel	Yes	
12.	Punching press	No	
UNIT II BALANCING			
13.	Static and dynamic balancing	No	**T1 & R3**
14.	Balancing of Rotating Masses	Yes	
15.	Balancing of several masses	Yes	
16.	Primary unbalanced force of reciprocating parts	Yes	
17.	Secondary unbalanced force of reciprocating parts	Yes	
18.	Unbalance in several Planes	No	
19.	Balanced force – unbalanced moments	No	
20.	effect of balancing on shaking and pin forces	Yes	
21.	Analysis of Static Unbalance	Yes	
22.	Analysis of Dynamic Unbalance	Yes	
23.	Firing order	Yes	
24.	Balancing of V and W engines	Yes	
UNIT III FREE VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEMS			
25.	Single Degree of Freedom (SDOF) System	No	**T2 & R1**
26.	Undamped Free Vibration	Yes	
27.	Damped Free Vibration	Yes	
28.	Fundamental of vibrations	No	
29.	Torsional vibrations and single rotor	Yes	
30.	Typical Response in Damped Harmonic Forced Vibration	No	
31.	Derivation and solution of differential equation	Yes	
32.	Equivalent stiffness of spring combinations- Bifilar	Yes	
33.	Trifilar suspensions		
34.	Damping coefficient	Yes	
35.	Critical damping coefficient	No	
36.	Logarithmic decrement	No	
UNIT IV FORCED VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEMS			

37.	Steady state response due to Harmonic Oscillation	No	**T1,T2 & R3**
38.	Harmonic Force from Imbalance Excitation	Yes	
39.	Rotating imbalance, Random forcing	Yes	
40.	Periodic forcing, Impulse response function	No	
41.	Rotating unbalance	Yes	
42.	Reciprocating unbalance	Yes	
43.	Energy dissipated by damping	No	
44.	Excitation by Forces with Arbitrary Time Function	Yes	
45.	Forced vibration with coulomb	Yes	
46.	Viscous damping	No	
47.	Vibration isolation and transmissibility	Yes	
48.	Vibration absorbers	No	
UNIT V CRITICAL SPEEDS AND SHAFTS WITH ROTORS			
49.	Whirling of shafts	Yes	**T1 & R2,R3**
50.	Rayleigh's Method	Yes	
51.	Dunkerley's Empirical Method	No	
52.	Critical speed of shafts	Yes	
53.	Lateral vibrations of beams	Yes	
54.	Combined loading	Yes	
55.	A Single-DOF Damped Rotor Model	No	
56.	Suppression of Critical Speeds	Yes	
57.	Shaft with two rotors- geared system	Yes	
58.	Shaft with three rotors- geared system	Yes	
59.	Dunkerley's Empirical Method – different types of beams	Yes	
60	Dunkerley's Empirical Method – shaft with several loads	Yes	

Teaching Strategies

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures
- Tutorials, which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material.
- Laboratory sessions, which support the formal lecture material and also provide the student with practical construction, measurement and debugging skills.
- Small periodic quizzes, to enable you to assess your understanding of the concepts.

Evaluation Strategies

Cycle Test – I	-	5%
Cycle Test – II	-	5%
Model Test	-	10%
Assignment / Seminar / Online Test / Quiz	-	5%
Attendance	-	5%
Final exam	-	70%

Prepared by R.Hariharan

Addendum

ABET Outcomes expected of graduates of B.Tech / MECH / program by the time that they graduate:

a) The ability to apply knowledge of mathematics, science, and engineering fundamentals.

b) The ability to identify, formulate and solve engineering problems.

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

d) The ability to design and conduct experiments, as well as to analyze and interpret data

e) The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

f) The ability to apply reasoning informed by the knowledge of contemporary issues.

g) The ability to broaden the education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

h) The ability to understand professional and ethical responsibility and apply them in engineering practices.

i) The ability to function on multidisciplinary teams.

j) The ability to communicate effectively with the engineering community and with society at large.

k) The ability in understanding of the engineering and management principles and apply them in project and finance management as a leader and a member in a team.

l) The ability to recognize the need for, and an ability to engage in life-long learning.

Program Educational Objectives

PEO1: PREPARATION:
Mechanical Engineering graduatesare enthusiastic to provide strong foundation in mathematical, scientific and engineering fundamentals necessary to analyze, formulate and solve engineering problems in the field of Mechanical Engineering.

PEO2: CORE COMPETENCE:
Mechanical Engineering graduates have competence to enhance the skills and experience in defining problems in the field of Mechanical Engineering and Technology design and implement, analyzing the experimental evaluations, and finally making appropriate decisions.

PEO3: PROFESSIONALISM:
Mechanical Engineering graduates made competence to enhance their skills and embrace new thrust areas through self-directed professional development and post-graduate training or education.

PEO4: PROFICIENCY:
Mechanical Engineering graduates became skilled to afford training for developing soft skills such as proficiency in many languages, technical communication, verbal, logical, analytical, comprehension, team building, inter personal relationship, group discussion and leadership skill to become a better professional.

PEO5: ETHICS:
Mechanical Engineering graduates are morally merged to apply the ethical and social aspects of modern Engineering and Technology innovations to the design, development, and usage of new products, machines, gadgets, devices, etc.

BME401 – DYNAMICS OF MACHINES

Course Teacher	Signature
R.Hariharan	
R.Karthikeyan	
R.Sabarish	
Jose anand vino V	
G.Anbazhagan	

Course Coordinator
Mr.Golden Ranjith
Nimal

HOD/MECH