Fall 2015

ENME 2750

W. St. Cyr
University of New Orleans

Draft ENME 2750-001 Syllabus

Dynamics – Fall 2015

Class: 2:00 – 3:15 M&W Science 2072

Recitation: 1:35 – 2:00 M&W Science 2072

Office Hours: 10:00 am to 12:30 pm, M&W

Instructor: W. St. Cyr, Ph.D.
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Lecture No.	Date		Text Sections	Homework Problems On "Connect", PLUS EXTRA
1	8/19	Kinematics	Intro; 11-1, 2, 3	
2	8/24	of	11-4, 5, 6	Extra 11-3, 5
3	8/26	Particles	11-9, 10, 11, 12	Extra 11-6, 9
4	8/31		11-13, 14	Extra 11-12, 15
5	9/2	Kinetics of	12-1, 2, 3, 4	Extra 11-17, 18
6	9/9	Particles:	Test on Chapter 11	
7	9/14	Newton's	12-5, 6	Extra 12-1, 3
8	9/16	Second Law	12-8, 9, 10	Extra 12-4, 6
9	9/21	Kinetics of	13-1, 2, 3, 4, 5	Extra 12-7, 8
10	9/23	Particles:	Test on Chapter 12	
11	9/28	Energy and	13-6, 8	Extra 13-1, 3
12	9/30	Momentum	13-10, 11	Extra 13-6, 7
13	10/5	Methods	13-12, 13, 14, 15	Extra 13-10, 12
14	10/7	Systems of Particles	14-1, 2, 3, 4, 5, 6	Extra 13-13, 15
15	10/12	Kinematics	Test on Chapter 13	
16	10/14	of	15-1, 2, 3, 4	Extra 14-1, 3
17	10/19	Rigid	15-5, 6	Extra 15-2, 4
18	10/21	Bodies	15-7, 8, 9	Extra 15-6, 8
19	10/26		15-10, 11	Extra 15-9, 11
20	10/28	Plane Motion	16-1 to 7	Extra 15-12, 14
21	11/2	of Rigid Bodies:	Test on Chapter 15	
22	11/4	Forces	16-1 to 7	Extra 16-1, 3
23	11/9	and	16.8	Extra 16-5, 7
24	11/11	Accelerations	16.8	Extra 16-9, 11
25	11/16	Plane Motion	17-1 to 17-7	Extra 16-13, 15
26	11/18	of Rigid Bodies:	Test on Chapter 16	
27	11/23	Energy and	17-8 to 17-10	Extra 17-
28	11/25	Momentum Methods	17-11 to 17-12	Extra 17-
29	11/30			Extra 17-
30	12/2			

Final Drop Date is Oct 14. Mid-semester break is Oct. 15-16. Thanksgiving is Nov. 26
Final Exam is Dec. 9

Course Schedule:

Two 75 minute lectures each week. Two 25 minute recitations each week. All classes required. Attendance will be taken and student status determined by both attendance and performance.

Prerequisites:

ENCE 2350, Statics and MATH 2112 (or MATH 2109), the third calculus course.

Student Learning Objectives

After completing this course, each student will be able to:

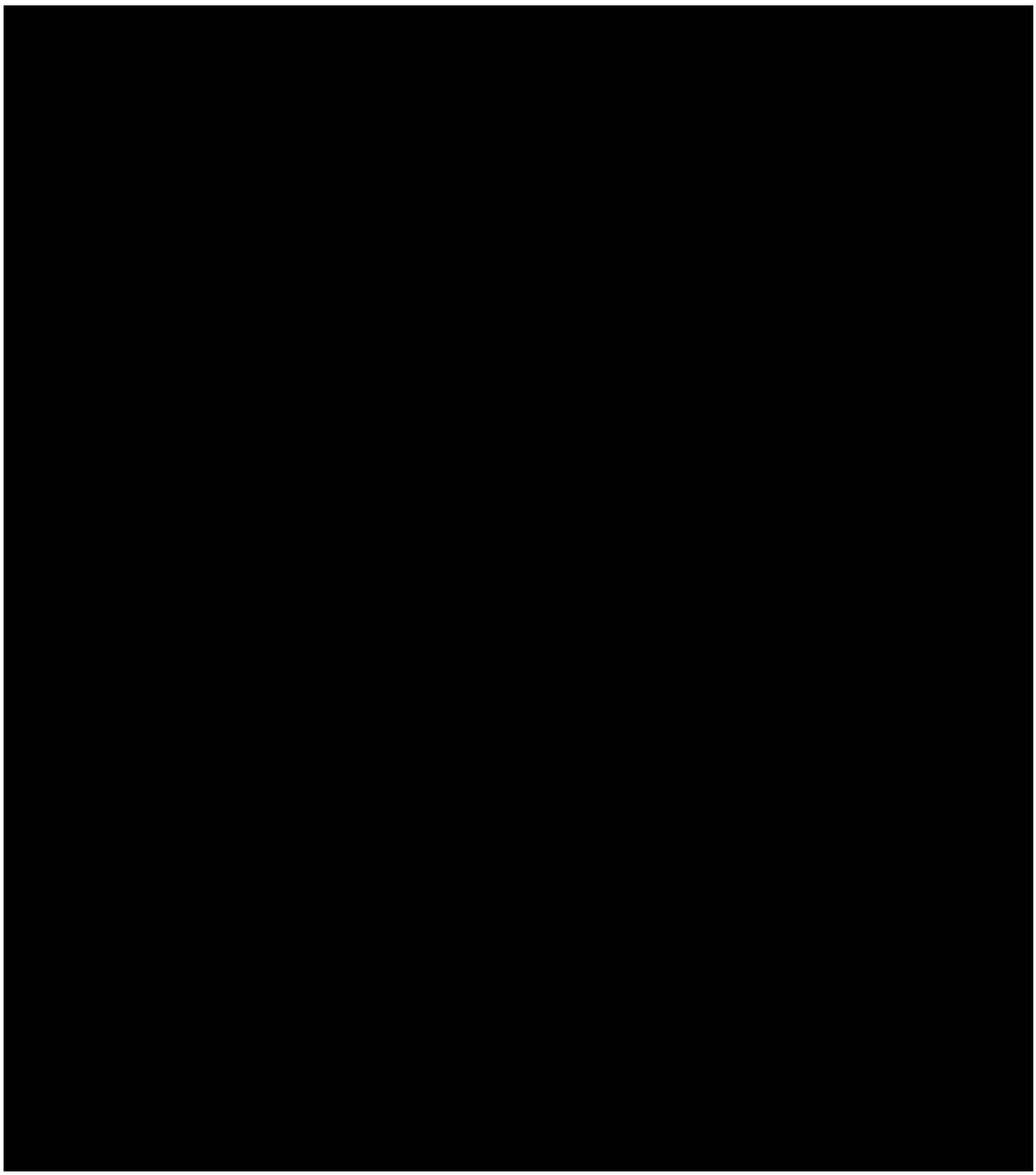
1. Apply methods and procedures using principles of vector calculus to describe and prescribe plane motions of particles and rigid bodies.
2. Apply methods and procedures using Newton Laws motion to solve plane motion problems of particle, rigid bodies, and systems of rigid bodies.
3. Apply methods and procedures using principles of work-energy to solve plane motion problems.
4. Apply methods and procedures using principles of impulse-momentum to solve plane motion problems**.**

Course Topics

1. Basic definitions, particle kinematics: coordinate systems – Cartesian rectangular, normal and tangential, and radial and transverse components, relative motions
2. Rigid body kinematics: relative motions, rigid bodies, rotating reference frames
3. Particle kinetics: Newton's laws, linear and angular momenta, motion of a system of particles
4. Rigid body kinetics: linear momentum, moments of inertia, angular momentum, general Newton-Euler equations of motion, plane motion of slab bodies
5. Work-energy principle: definition of work, potential and kinetic energy, mechanical energy theorem applied to systems of particles, rigid bodies, and systems of constrained rigid bodies.
6. Impulse-momentum: definition of impulse, impacts: direct central, coefficient of restitution, oblique central impacts, conservation of linear momentum. Angular momentum of rigid bodies

Required Textbook: Vector Mechanics for Engineers - Dynamics by Ferdinand P. Beer, E. Russel Johnson, Jr., and William E. Clausen 10^{th} edition, McGraw-Hill (9^{th} edition is also acceptable)

Required Work: Approximately two-thirds of the homework is to be completed and submitted on line. Additional problems to be worked and handed in are listed on the first page of this syllabus. These additional problems can be found on my gmail site. Supply me with your gmail address and you will be given access.



MY RULES IN DYNAMICS FOR SUBMITTED WORK

1) All final answers must list magnitude, units, and if a vector the direction of the vector. No negatives in the answer. Vector direction specified in degrees from horizontal. Displacements, positions, velocities and accelerations are VECTORS. Tension in a rope, cable, etc., speed and distance traveled are SCALARS.

2) Draw a box around any answer you want graded.

3) All vectors must be written with an arrow over the variable name.
   Points may be deducted for any vector quantity without an arrow.
   Points will be deducted for any scalar quantity with an arrow.

4) All final answers must be reported (rounded) to slide rule accuracy. If the answer begins with a "1", four significant figures are reported. Otherwise, three significant figures are reported. "Significant Figures" is not the same as "Decimal Digits".

5) All calculations must be done to at least five significant figures. Round only the final answers.

6) Use a separate sheet of paper for each problem. Do not write on the back of the paper. Be neat and organized. **Use a straight edge and circle template or compass.**

7) Write down the equation you are using before substituting numeric values.
   Indicate the positive directions when summing forces and moments.
   Position the equation(s) and evaluations adjacent to the FBD.

8) Show intermediate steps if you want partial credit for the problem. Don't leave out steps.

9) All problems require a sketch or FBD. If Newton's Law is to be used, a complete and correct FBD is mandatory.

10) The coordinate system and origin of the coordinate system must be shown on the sketch or near the FBD. Label coordinate axes indicating positive directions.

11) Use a consistent set of units. Don't mix feet and inches in the same problem.

12) Never work in "hours". Acceleration of gravity is in ft/s^2, in/s^2 or m/s^2.

Attendance Policy

Class participation and attendance (lecture and recitation) is NOT optional. (Roll will be taken <u>every</u> day!).

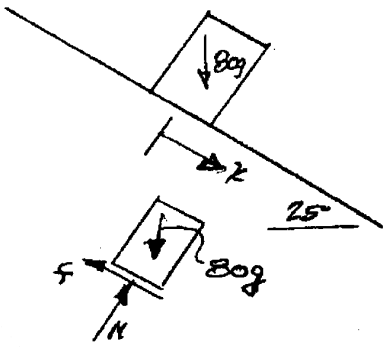
Excessive unexcused absences will result in loss of at least one letter grade!

Class begins promptly at 2:00 pm and ends no later than 3:15 pm. Recitation periods are from 1:35 to 2:00 on Mondays and Wednesdays. Attendance is NOT optional.

Homework Format Example

ENME 2750-601 | W. W. St. Cyr

14.8) GIVEN: 25° SKI SLOPE
$m = 80$ kg
$\mu_s = 0.08$
At $t = 0$ $v = 9$ m/s



FIND: ACCELERATION
VELOCITY AT $x = 20$m

SOLUTION: $+\Sigma F_x = ma_x$

① $(80g)\sin 25 - f = 80a_x$

$+\nearrow \Sigma F_y = ma_y = 0$

② $N - (80g)\cos 25 = 0$

③ $f = \mu_s N = 0.08N$

3 EQUATIONS IN 3 UNKNOWNS a_x, N, f

$N = (80)(9.81)(\cos 25) = 711.27$ N

$f = .08N = .08(711.27) = 56.90$ N

$80a_x = (80)(9.81)(\sin 25) - 56.90 = 274.77$

$\vec{a}_x = 3.43$ m/s² 25° (CONSTANT)

$a_x = 3.434 = \frac{dv_x}{dt} = \frac{dv_x}{ds}\frac{dx}{dt} = \frac{dv_x}{ds}v_x$

$v_x\, dv_x = 3.434\, dx$

$\frac{1}{2}v_x^2 = 3.434x + C_1$

AT $x = 0$ $v_x = 9$ m/s

$\frac{1}{2}(9)^2 = 3.434(0) + C_1$ $\quad C_1 = 40.5$

$\therefore v_x = \sqrt{81 + 6.869x}$

AT $x = 20$ $\quad v_x = \sqrt{81 + 137.38} = 14.78$

$\vec{v}_x|_{x=20m} = 14.8$ m/s 25°

Examinations and Grading

All quizzes and examinations are **CLOSED BOOK** and **CLOSED NOTES**, and you are expected to follow the same format and rules listed above. A formula sheet will be provided. There will be five one hour exams (100 points each), plus a two hour comprehensive final exam (200 points). If you must miss an exam, you are required to make arrangements for rescheduling the exam the week **before** the scheduled exam time. Homework ("Connect" plus "Extra") counts as a one hour exam. Total possible points will be 800. With averages of 90%, 80%, 70%, you are guaranteed an "A", "B", or "C", respectively.

Expected Conduct

I will treat you with respect and expect to be treated with respect by you. I will address you by your last name, and expect you to address me as Dr. St. Cyr. I may provide name card to everyone to help me learn your names. Please use them for every class if provided.

I encourage classroom participation. Ask questions. Point out the math mistakes I make during class (I make many). Ask me to go over something again (and again) if you didn't follow what I did.

I cannot tolerate interruptions in class due to ringing phones or chirping beepers. Those devices must be silenced when you enter the classroom. Otherwise I will ask you to leave the classroom and not return for the remainder of the period. If you must leave the classroom for any reason, and do so without permission, do not return for the remainder of that period.

Other useful information:

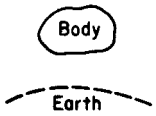
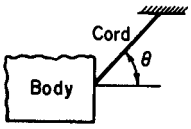
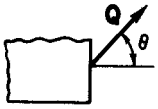
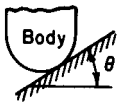
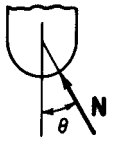
velocity: 1 ips = 1 in/s = 1 inch per second
1 fps = 1 ft/s = 1 foot per second

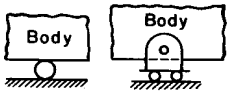
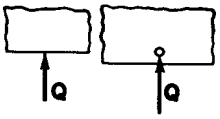
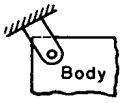
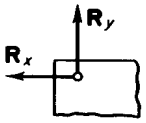
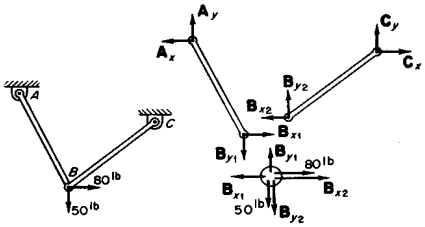
acceleration: $1\ \text{ips}^2 = 1\ \text{in/s}^2 = 1$ inch per second^2 = 1 inch per second per second
$1\ \text{fps}^2 = 1\ \text{ft/s}^2 = 1$ foot per second^2 = 1 foot per second per second

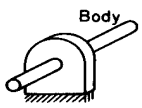
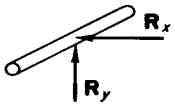
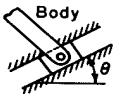
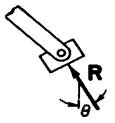
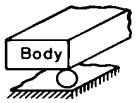
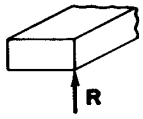
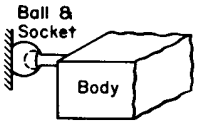
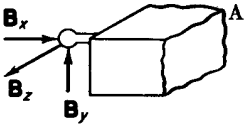
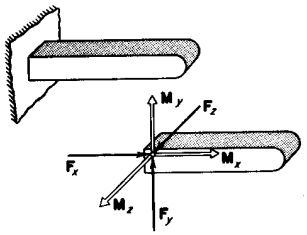
Free Body Diagrams A *free-body diagram* is a sketch of body, a portion of a body, or two or more bodies completely isolated or free from all other bodies, showing the forces exerted by all other bodies on the one being considered.

Three Essential Characteristics of a FBD

- It is a diagram or sketch of the body.
- The body is shown completely separated (isolated, cut free) from all other bodies including foundations, supports, and so on.
- The action on the body of each body removed in the isolating process is shown as a force or forces on the diagram.

Name of Body to Be Removed	*Sketch of Reacting Bodies*	*Action of Body Removed*	*Description*
Earth			Always a vertical force equal to the weight and passing through the center of gravity of the body
Flexible cord, rope, cable (weight neglected)			Always a single force (tension) along the cord
Smooth surface			Always a single force perpendicular to the smooth surface

Name of Body to be Removed	*Sketch of Reacting Bodies*	*Action of Body Removed*	*Description*
Roller			Always a force perpendicular to the surface on which roller can roll
Smooth pin			A force through the pin at an unknown angle; usually shown as two independent components
Smooth pin with additional forces on pin			A force through the pin at an unknown angle or two independent components as shown here. Notice equal opposite action of members on pin with applied loads acting on pin

Name of Body to Be Removed	*Sketch of Reacting Bodies*	*Action of Body Removed*	*Description*
Smooth bearing on a shaft			A force normal to the shaft at an unknown angle; usually shown as two independent components
Pin or runner in a smooth guide or slot			A force normal to the guide or slot
Ball support			A single force normal to the contact surface
Ball and socket			A force at the ball at an unknown angle; usually shown as three independent components
Support for a beam or post fixed at the end, three-dimensional case			A force and a moment shown here as three independent component forces and three independent component moments; for two dimensional problems (all forces in xy plane) omit $\mathbf{F}_z$, $\mathbf{M}_x$, and $\mathbf{M}_y$.

Some Common FBD Errors

- Bodies were not FREE. (That's the "F" in FBD)
- Bodies were not represented as bodies, only points. (That's the "B")
- Missing forces.
- Forces not located where they act.
- Labeling force of gravity as "g".
- Unknown forces not labeled.
- Inconsistent naming of unknown forces.
- Making assumptions on force magnitudes.
- Rotating bodies to horizontal position when they're not horizontal.

Note: $g = 9.81\ m/s^2 = 32.2\ ft/s^2 = 386\ in/s^2$