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OFFICE OF THE SENATE COUNCIL

1. General Information

1a. Submitted by the College of: ENGINEERING

Date Submitted: 2/25/2014

1b. Department/Division: Department of Biomedical Engineering

1c. Contact Person

Name: David Pienkowski

Email: pienkow@uky.edu

Phone: 859-218-1667

Responsible Faculty ID (if different from Contact)

Name:

Email:

Phone:

1d. Requested Effective Date: Specific Term/Year [1] Fall 2015

1e. Should this course be a UK Core Course? No

2. Designation and Description of Proposed Course

2a. Will this course also be offered through Distance Learning?: No

2b. Prefix and Number: BME 472

2c. Full Title: Human Biomechanics

2d. Transcript Title: Human Biomechanics

2e. Cross-listing:

2f. Meeting Patterns

LECTURE: 3

2g. Grading System: Letter (A, B, C, etc.)

2h. Number of credit hours: 3

2i. Is this course repeatable for additional credit? No

If Yes: Maximum number of credit hours:

If Yes: Will this course allow multiple registrations during the same semester?

2j. Course Description for Bulletin: This course presents an engineering-based approach to the quantitative study of the human musculoskeletal system. Principles involving static and dynamic mechanical analyses will be applied to quantify the forces and moments in human posture and movement. Study of the material and biological properties of the musculoskeletal system is included because they are intimately coupled to the formulation and interpretation of problems in static and dynamic biomechanics.

2k. Prerequisites, if any: EM 221, EM 313; or consent of instructor

2l. Supplementary Teaching Component:

3. Will this course taught off campus? No

If YES, enter the off campus address:

4. Frequency of Course Offering: Fall,

Will the course be offered every year?: Yes

If No, explain:

5. Are facilities and personnel necessary for the proposed new course available?: Yes

If No, explain:

6. What enrollment (per section per semester) may reasonably be expected?: 20

7. Anticipated Student Demand

Will this course serve students primarily within the degree program?: No

Will it be of interest to a significant number of students outside the degree pgm?: Yes

If Yes, explain: This course will be of interest to students in other engineer disciplines. It may be able to serve as a free or technical elective.

8. Check the category most applicable to this course: Traditional – Offered in Corresponding Departments at Universities Elsewhere,

If No, explain:

9. Course Relationship to Program(s).

a. Is this course part of a proposed new program?: Yes

If YES, name the proposed new program: Minor in Biomedical Engineering

b. Will this course be a new requirement for ANY program?: No

If YES, list affected programs:

10. Information to be Placed on Syllabus.

a. Is the course 400G or 500?: No

b. The syllabus, including course description, student learning outcomes, and grading policies (and 400G-/500-level grading differentiation if applicable, from **10.a** above) are attached: Yes

Distance Learning Form

Instructor Name:

Instructor Email:

Internet/Web-based: No

Interactive Video: No

Hybrid: No

1.How does this course provide for timely and appropriate interaction between students and faculty and among students? Does the course syllabus conform to University Senate Syllabus Guidelines, specifically the Distance Learning Considerations?

2.How do you ensure that the experience for a DL student is comparable to that of a classroom-based student's experience? Aspects to explore: textbooks, course goals, assessment of student learning outcomes, etc.

3.How is the integrity of student work ensured? Please speak to aspects such as password-protected course portals, proctors for exams at interactive video sites; academic offense policy; etc.

4.Will offering this course via DL result in at least 25% or at least 50% (based on total credit hours required for completion) of a degree program being offered via any form of DL, as defined above?

If yes, which percentage, and which program(s)?

5.How are students taking the course via DL assured of equivalent access to student services, similar to that of a student taking the class in a traditional classroom setting?

6.How do course requirements ensure that students make appropriate use of learning resources?

7.Please explain specifically how access is provided to laboratories, facilities, and equipment appropriate to the course or program.

8.How are students informed of procedures for resolving technical complaints? Does the syllabus list the entities available to offer technical help with the delivery and/or receipt of the course, such as the Information Technology Customer Service Center (http://www.uky.edu/UKIT/)?

9.Will the course be delivered via services available through the Distance Learning Program (DLP) and the Academic Technology Group (ATL)? NO

If no, explain how student enrolled in DL courses are able to use the technology employed, as well as how students will be provided with assistance in using said technology.

10.Does the syllabus contain all the required components? NO

11.I, the instructor of record, have read and understood all of the university-level statements regarding DL.

Instructor Name:

SIGNATURE|PULEO|David A Puleo|BME 472 NEW Dept Review|20140225

SIGNATURE|BJSTOK0|Barbara J Brandenburg|BME 472 NEW College Review|20140909

SIGNATURE|JMETT2|Joanie Ett-Mims|BME 472 NEW Undergrad Council Review|20150203

Courses	Request Tracking

New Course Form

https://myuk.uky.edu/sap/bc/soap/rfc?services=

Open in full window to print or save

Generate R

Attachments:

Browse... Upload File

	ID	Attachment
Delete	4361	BME 472 Syllabus rev 2-3-15.doc

First 1 Last

Select saved project to retrieve... Get New

(*denotes required fields)

1. General Information

a. * Submitted by the College of: ENGINEERING Submission Date: 2/25/2014

b. * Department/Division: Department of Biomedical Engineering

c.
* Contact Person Name: David Pienkowski Email: pienkow@uky.edu Phone: 859-218-1667
* Responsible Faculty ID (if different from Contact) Email: Phone:

d. * Requested Effective Date: ○ Semester following approval OR ◉ Specific Term/Year [1] Fall 2015

e.
Should this course be a UK Core Course? ○ Yes ◉ No
If YES, check the areas that apply:

☐ Inquiry - Arts & Creativity	☐ Composition & Communications - II
☐ Inquiry - Humanities	☐ Quantitative Foundations
☐ Inquiry - Nat/Math/Phys Sci	☐ Statistical Inferential Reasoning
☐ Inquiry - Social Sciences	☐ U.S. Citizenship, Community, Diversity
☐ Composition & Communications - I	☐ Global Dynamics

2. Designation and Description of Proposed Course.

a. * Will this course also be offered through Distance Learning? ○ Yes [4] ◉ No

b. * Prefix and Number: BME 472

c. * Full Title: Human Biomechanics

d. Transcript Title (if full title is more than 40 characters): Human Biomechanics

e. To be Cross-Listed [2] with (Prefix and Number):

f. * Courses must be described by at least one of the meeting patterns below. Include number of actual contact hours[3] for each meeting pattern type.

3	Lecture		Laboratory[1]		Recitation		Discussion
	Indep. Study		Clinical		Colloquium		Practicum
	Research		Residency		Seminar		Studio
	Other	If Other, Please explain:					

g. * Identify a grading system:
◉ Letter (A, B, C, etc.)
○ Pass/Fail
○ Medicine Numeric Grade (Non-medical students will receive a letter grade)
○ Graduate School Grade Scale

h. * Number of credits: 3

i. * Is this course repeatable for additional credit? ○ Yes ◉ No
If YES: Maximum number of credit hours:
If YES: Will this course allow multiple registrations during the same semester? ○ Yes ○ No

j. * Course Description for Bulletin:

This course presents an engineering-based approach to the quantitative study of the human musculoskeletal system. Principles involving static and dynamic mechanical analyses will be applied to quantify the forces and moments in human posture and movement. Study of the material and biological properties of the musculoskeletal system is included because they are intimately coupled to the formulation and interpretation of problems in static and dynamic biomechanics.

k. Prerequisites, if any:

EM 221, EM 313; or consent of instructor

l. Supplementary teaching component, if any: ○ Community-Based Experience ○ Service Learning ○ Both

3. *** Will this course be taught off campus?** ○ Yes ◉ No

If YES, enter the off campus address:

4. **Frequency of Course Offering.**

a. * Course will be offered (check all that apply): ☑ Fall ☐ Spring ☐ Summer ☐ Winter

b. * Will the course be offered every year? ◉ Yes ○ No

If No, explain:

5. *** Are facilities and personnel necessary for the proposed new course available?** ◉ Yes ○ No

If No, explain:

6. *** What enrollment (per section per semester) may reasonably be expected?** 20

7. **Anticipated Student Demand.**

a. * Will this course serve students primarily within the degree program? ○ Yes ◉ No

b. * Will it be of interest to a significant number of students outside the degree pgm? ◉ Yes ○ No

If YES, explain:

This course will be of interest to students in other engineer disciplines. It may be able to serve as a free or technical elective.

8. *** Check the category most applicable to this course:**

☑ Traditional – Offered in Corresponding Departments at Universities Elsewhere
☐ Relatively New – Now Being Widely Established
☐ Not Yet Found in Many (or Any) Other Universities

9. **Course Relationship to Program(s).**

a. * Is this course part of a proposed new program? ◉ Yes ○ No

If YES, name the proposed new program:

Minor in Biomedical Engineering

b. * Will this course be a new requirement [5] for ANY program? ○ Yes ◉ No

If YES [5], list affected programs::

10. **Information to be Placed on Syllabus.**

a. * Is the course 400G or 500? ○ Yes ◉ No
If YES, the *differentiation for undergraduate and graduate students must be included* in the information required in **10.b**. You must include: (i) identi additional assignments by the graduate students; and/or (ii) establishment of different grading criteria in the course for graduate students. (See SR

b. ☑ * The syllabus, including course description, student learning outcomes, and grading policies (and 400G-/500-level grading differentiation if appl **10.a** above) are attached.

[4] Courses are typically made effective for the semester following approval. No course will be made effective until all approvals are received.
[5] The chair of the cross-listing department must sign off on the Signature Routing Log.

[1] In general, undergraduate courses are developed on the principle that one semester hour of credit represents one hour of classroom meeting per week for a semester, exclusive of any laboratory meeting. Laboratory meeting, generally, re two hours per week for a semester for one credit hour. (from SR 5.2.1)
[2] You must also submit the Distance Learning Form in order for the proposed course to be considered for DL delivery.
[3] In order to change a program, a program change form must also be submitted.

Rev 8/09

Submit as New Proposal Save Current Changes

UNIVERSITY OF KENTUCKY
DEPARTMENT OF BIOMEDICAL ENGINEERING
BME 472
Human Biomechanics
COURSE SYLLABUS

Spring, 2015
MN 680 Willard Building
T 5 – 8 PM
3 credit hours
email

Instructor: David Pienkowski, Ph.D.
Office: 514F Robotics Building
Telephone: 218-1667
Hours: by appointment
pienkow@uky.edu

Course Description
This course presents an engineering-based approach to the quantitative study of the human musculoskeletal system. Principles involving static and dynamic mechanical analyses will be applied to quantify the forces and moments occurring in human joints in response to posture and the activities of daily living. Prefatory study of the material and biological properties of the musculoskeletal system is essential for development of relevant approximations and assumptions needed to develop tractable engineering formulations, solutions, and interpretation of problems in static and dynamic biomechanics.

Course Objectives:
1. to present an overview of musculoskeletal biomechanics from an engineering perspective,
2. to develop the quantitative relationships among structure, properties, and functions of natural and prosthetic musculoskeletal tissues, organs, and materials; and
3. to instill competence in formulation, solution, interpretation, and application of practical static and dynamic problems in biomechanics.

Course Modules:
1. material aspects of the musculoskeletal system
2. static biomechanical analyses of human joints
3. kinematics and coordinate system rotations
4. kinetics of human motion.

Lecture Schedule:
Lectures will be based upon the topics shown, except that the timing and content of the lectures may change due to the varying backgrounds of the students and the instructor's travel schedule. Lectures may end early or late to achieve logical "breakpoints" in the lecture material. Due to the small class size, the instructor reserves the right to postpone class if sufficient students do not attend. Instructor-missed classes will be rescheduled and make-up classes added.

No classes: Feb 17 (AAFS Conference)
March 9 (Spring Break)
March 31 (ORS Conference)
Last class: April 28

Module I: Components of the Musculoskeletal System

1. Introduction	(1/13)	foundations of biomechanics
2. Materials I	(1/20)	tendon & ligament
3. Materials II	(1/27)	muscle
4. Materials III	(2/3)	bone
5. Materials IV	(2/10)	bone & skeletal articulations
exam #1:	(2/17)	MN 642 Willard; 5 – 7 PM

Module II: Static Biomechanical Analysis of the Musculoskeletal System

6. Static Biomechanics I	(2/24)	introduction to statics & traction
7. Static Biomechanics II	(3/3)	lower extremity: knee
8. Static Biomechanics III	(3/4)	lower extremity: hip
9. Static Biomechanics IV	(3/17)	upper extremity: hand/elbow/shoulder
10. Static Biomechanics: V	(3/18)	spine
11. Static Biomechanics VI	(3/24)	spine disorders & static indeterminacy
12. Static Biomechanics VII	(3/25)	make-up class (if needed)
exam #2:	(3/31)	MN 642 Willard; 5 – 7 PM

Module III: Kinematics of Human Motion

13. Kinematics I	(4/7)	fundamentals of human movement
14. Kinematics II	(4/8)	rotational coordinate transformations
15. Kinematics III	(4/14)	rotational coordinate transformations
exam #3:	(4/15)	MN 642 Willard; 5 – 7 PM

Module IV: Dynamics of Human Motion

16. Dynamics I	(4/21)	fundamentals of dynamics
17. Dynamics II	(4/22)	kinetics and human movement
18. Dynamics III	(4/23)	whole body dynamics

19. Dynamics IV (4/28) whole body dynamics

Final Exam: as per the schedule established by the Registrar, subject to alteration to accommodate student's other exams, project assignments, or travel schedules. Alterations to the final exam schedule require unanimous approval of all students.

Examinations
There will be 3 exams each 1-2 hours in duration. Exams will ideally be held during regular class times when the instructor is out of town. If this is not permissible, then exams will be held on Wednesday evenings beginning at 5 PM and continuing for either one or two hours. All exams will be held in room MN 642 Willard Building. Each exam will include the material in the immediately preceding course module. The final exam will be comprehensive, 3 hours in duration, and may include a take-home component.

Exams require two blue or black pens (no pencils) to record your answers. A ruler and a simple calculator are also recommended. Calculators within cell phone are NOT permitted in the exam room. No other books, book bags, note sheets, briefcases, knapsacks, etc. will be permitted in the exam room. I may also implement "surprise" quizzes at my discretion. Please come to each class prepared for a surprise quiz and if one occurs, you will not be disappointed. Examinations will be graded and returned to the students for in-class examination only. No exams will leave the exam room or the class room unless specifically noted as a "take-home" exam. Students will be given time to review their graded exams during regularly scheduled class time. If this is insufficient, arrangements can be made between the student and the instructor for additional exam review time, but in no case will any (except take-home) exams be allowed to leave the class room.

I understand that "things happen" and exams or quizzes must be missed. I will arrange a make-up examination or quiz for a student who misses an examination or quiz and has one of the excuses listed under Senate Rule 5.2.4.2. No make-up exams or quizzes will be provided for students who miss exams or quizzes due to reasons not included in Senate Rule 5.2.4.2. A grade of zero will be entered into the record for missed exams or quizzes.

Performance Evaluation:
Evaluation of the student's performance is based upon the instructor's assessment of student progress based upon relative and absolute standards. The semester's overall performance rating will be determined by using the following approximate guide:

exam #1:	15%
exam #2:	20%
exam #3:	15%
quizzes	10%
Final Exam:	40%
Class involvement	+%
	100%

Attendance, class involvement, and attitude will also be used to determine the final grade. These factors will be used to change, or not change, the final grades given for "borderline" cumulative course scores. The instructor may also adjust the grading of such undergraduate students as he deems appropriate and fair.

Attendance:
To do well in this course, students need to attend class, take good notes and study them, as well as practice solving biomechanics problems. Attendance is an indicator of success. Unexcused absences reflect poorly upon the interest of the student and his or her willingness to learn. Class attendance is also important because the material in this course is not readily found in textbooks. Role will be taken and unacceptable absences will adversely affect the students grade. Absences are acceptable if: 1) excused in advance (I prefer an email note) 2) or they are for a bona fide (my decision) reason, and 3) if the notes from the missed class are obtained from another classmate, studied and assimilated into the students notebook. Because attendance is mandatory, beginning with the third and for each subsequent unexcused absence, your final average will be lowered by 2 percentage points. To be counted as present, you must be present for the entire class session. If any student misses in excess of 20% of the total instructional class hours, the instructor retains the right to ask the student to withdraw even if the absences are excusable.

Acceptable reasons for "excused" absences are defined by Senate Rule 5.2.4.2 and include:
1) serious illness;
2) illness or death of "family" member;
3) University-related trips;
4) major religious holidays;
5) other circumstances that I determine are "reasonable cause for nonattendance".

Class Participation
I expect each student to be following the lecture carefully and remain current with regard to the issues discussed. This means I expect students will be ready to answer questions posed regarding the current classroom topic. I also expect students to ask questions, especially the "what if's" regarding alternative scenarios.

Classroom Behavior, Decorum and Civility
Classroom demeanor is an increasingly significant problem on campus (and nationally). The Department for Biomedical Engineering respects the dignity and differences of members of our academic community. The instructor recognizes the right of all students to respectfully disagree from time-to-time, take reasoned exception, and to voice opinions contrary, to those offered by the instructor or other students (c.f. Senate Rule 6.1.2). Equally, the instructor has the right, and the responsibility, to ensure that all academic discourse occurs in a context characterized by respect and civility. In short, "...it's acceptable to disagree with the instructor or your classmates, but don't be disagreeable while doing so".

Class Enrollment
Students who are attending class but are not on the class roll (i.e., not enrolled) will be directed to the Registrar. I adhere to University regulations that note the lack of obligation by the University to instruct students in a classroom setting: a) unless said students first enroll, or b) if the enrollment of such students becomes nullified during the semester.

Learning
This is an upper-level undergraduate course, and as such, learning and intellectual development are primarily the responsibility of the student as guided by the instructor. Students must *study* their notes outside of class, engage in supplemental reading, formulate, and solve (earlier) problems on their own without the aid of notes, and think about how the material presented in all four course modules is qualitatively and quantitatively linked to human posture, motion, and performance of daily living tasks. As an approximate guide, a minimum of 10

hours of study per week outside of class time is needed to provide a solid basis for understanding the course material.

Learning Styles and Attitude
Students learn at different rates and by different methods (visual vs. verbal, example vs. concepts, repetition vs. exposure, etc.). Since I do not have sufficient class time to establish each of your particular learning styles, I will use all of the above methods to deliver the class material to help ensure that each student develops proficiency in biomechanics.

While an engineering or science background is useful for the mathematical skills such backgrounds require, experience shows that student dedication and persistence are more important than mathematical skills alone. Experience also shows that students from non-engineering and "biological" backgrounds frequently have difficulty completing the course successfully.

Learning Environment Expectations:
I expect all students to have a mature desire to learn biomechanics. I expect this maturity to be manifested by: classroom attendance, participation, and etiquette, as well as by clear, orderly, and timely (submit at the beginning of the class in which it is due) performance for any assignments. Failure to adhere to classroom etiquette (excessive talking during lecture, and any other activities which interfere with the learning of others) will be dealt with by verbal warnings, reduced grade, and if necessary, report to the Dean of Students (followed by potential punishable disciplinary action). Grade reductions will consist of: 1% reduction in the final overall course grade for the first offense, an additional 3% reduction in the final overall course grade for the second offense, and an additional 5% reduction in the final overall course grade for the third offense.

My Commitment to Your Education
I care that you learn biomechanics not just because it's my job, but because it is useful in improving the lives of people with bone or joint diseases, those suffering from traumatic injuries, or those with congenital malformations. Biomechanics provides the foundation for restoring pain-free human movement and normal life quality. Biomechanics forms the basis for all Orthopaedic treatments as well as all of the biomaterials used to repair or replace original living tissues in the musculoskeletal system. Because biomechanics is so important to normal daily human living, there are many rewarding career opportunities in biomechanics. A major goal of this course it to provide students with a solid engineering foundation in biomechanics so that students who successfully complete this course can compete for these careers. If I am unable to teach you these skills, for whatever reason, please communicate this to me in public or private and I'll arrange for supplemental class instruction or review sessions for the entire class. I will, as time and opportunity permit, also invite guest instructors to lecture and provide examples or opportunities to experience real-world devices or procedures that will aid student learning of the materials presented in class.

Student Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Explain the structure-property-function relationships of bone, muscle, tendon, ligament, and cartilage from the nano-scale to the macro-scale, and the biomechanical interrelationships of these constituent tissues with the musculoskeletal system,
2. Identify problems in static and dynamic biomechanics, prepare reasonable (based upon skills learned as per learning outcome #1) biomechanical models, solve these models using quantitative engineering techniques, and provide meaningful interpretation(s) of these quantitative outcomes
3. Use advanced vector-based biomechanical methods to solve the musculoskeletal problems developed as per learning outcome #2.
4. Provide, based upon learning outcomes #1 - #3, scholarly qualitative and quantitative explanations for most of the common disorders afflicting human bone and joints.

Academic Offenses

Academic integrity is important to scholarship. The prevalence of cheating on campuses across the country appears to be unacceptably widespread. This is disturbing not only to the faculty but to the many students who choose not to cheat. Cheating and plagiarism are offenses that I take seriously and for which I have zero tolerance. Students caught cheating will receive a failing grade for the entire course. **UNIVERSITY REGULATIONS REGARDING CHEATING AND PLAGIARISM WILL BE STRICTLY ENFORCED.**

To help safeguard against cheating, I reserve the right to implement any or all of the following during exams:

- assign or change seating in the exam room,
- prohibit cell phones/pagers from being brought into the examination room,
- require students to place all personal effects out of view in the examination room,
- prohibit the wearing of wide-brimmed caps or hats,
- consider that "talking during the exam" will be construed as cheating;
- create a "sign-in" sheet and compare signatures on the exams with those on the sign-in sheet;
- examine the desktops during the examination and require removal of any extraneous material;
- monitor carefully all segments of the room at regular intervals during the examination;
- announce that anybody leaving the classroom during the exam will not be allowed to return,
- confiscate all evidence of cheating immediately and without comment.

Textbook

No text fits the needs of the course well. Every text is a compromise. Material for the course comes from approximately 18 textbooks & numerous articles. In essence, the course material is a text unto itself - hence the need for attendance. This is not uncommon – a survey of 9 biomechanics courses at other leading universities* shows the paucity of appropriate textbooks for teaching graduate biomechanics.

Supplemental Materials:

When needed, copies of important supplemental materials will be provided via Blackboard. I recommend you physically print and incorporate such material into your note books and then study these materials as diligently as you study your class notes.

Late Arrival:

If the class must be held in a room other than MN 680, then because my office or lab may be remotely located from the alternative classroom, I may be delayed while in route to class. Please, in the event of lateness on my behalf, give me 15 minutes courtesy time before you leave the classroom and assume that there will be no class. If I am going to be later than 15

minutes, I will call an assistant and ask her to write a note on the board explaining the circumstances and the time of my expected arrival.

In the Event of Severe Weather:
It's the Spring semester, and if this spring is like last Spring, then there may be times when the University may be closed. I try to get in despite the weather; however, I recommend you call my office if you are uncertain if we will have class. For official University information, refer to:

UK TV cable channel 16
UK radio (WUKY 88.9 FM)
UK infoline 257-5684
UK website www.uky.edu

Recommended Reading:

Brand, Paul W: *Clinical* Mechanics of the Hand. C.V. Mosby, St. Louis, 1985

Cowin SC: *Bone Mechanics*. CRC Press, Boca Raton, 1989

Daniel DW, WH Akeson, JJ O'Connor: *Knee Ligaments: Structure, Function, Injury, and Repair*. Raven Press, New York, 1990

Engineering Mechanics, Volume 1: Statics. 4th Edition. J.L. Meriam, L.G. Kraige. Wiley & Sons, New York, 1997. Eng. TA 350 .M458 1997

Fung YC: *Biomechanics*, Springer-Verlag, New York, 1988

McMahon TA: Muscles, Reflexes, and Locomotion, Princeton University Press, 1984 (a classic reference on muscle)

Meriam JL, Kraige LG. *Engineering Mechanics* Volume I: Statics, John Wiley & Sons, New York, 1997, Engr TA 350 .M458, 1997 (an excellent up-to-date statics reference)

Mow VC and Hayes WC (eds): *Structure and Function of Articular Cartilage*, CRC Press, Boca Raton, 1993

Mow VC, Ratcliffe A, Woo SLY (eds): *Biomechanics of Diarthroidal Joints*, Springer-Verlag, New York, 1990 (Vols. 1 and 2)

Nigg BM and Herzog W: Biomechanics of the Musculo-skeletal System, Wiley, 2007

Ozkaya N, Nordin M: *Fundamentals of Biomechanics, Equilibrium, Motion, and Deformation*. Van Nostrand Reinhold, New York, 1991

Winter DA. Biomechanics and Motor Control of Human Movement Wiley, 2009

Woo SLY, Buckwalter JA (eds): *Injury and Repair of the Musculoskeletal Soft Tissues*, American Academy of Orthopaedic Surgeons, Park Ridge, 1988

* Saul et al, "Teaching Biomechanics", American Society for Biomechanics, Long Beach, CA, 12 August 2011

2/2/15