

2022

PT 412: BIOMECHANICS AND KINESIOLOGY
DEPARTMENT OF PHYSICAL THERAPY
SPRING SEMESTER 2022

Course Description: Biomechanics and kinesiology of musculature acting on the extremities and trunk. Clinical applications and evaluation of joint integrity and mobility, gait, range of motion and muscle performance. Laboratory. Prerequisite: Registered in Professional Physical Therapy Curriculum. S.

Department Offering the Course and Instructor(s):
Physical Therapy

Credits: 4

Course Coordinator
Mark Romanick, PT, PhD, ATC

Course Instructors:
Meridee Danks, PT, DPT, NCS
Steve Halcrow, PT, DPT, OCS
Ricky Morgan, PT, DPT, OCS, Cert MDT

Clock Hours:
Lecture: 32 hours
Lab: 64 hours

Class Hours:
Tuesdays and Thursdays
9 am – 10 am (lecture) Rm W202; 10 am – 12 noon (lab) Rm E312

Course Prerequisites:
Registered in Professional Physical Therapy Curriculum

Course Objectives:
After the completion of this course, the student will be able to:

- A. **Discuss anatomical planes, axes and human body movement description.**
 1. Describe the anatomical position and the position of the three cardinal planes
 2. Explain the concept of axes and planes of motion
 3. Define the term degrees of freedom
 4. Describe and contrast open vs closed kinematic chains
 5. List different types of joints and describe their anatomical/functional roles
 6. Define the terms agonist, antagonist, synergist, primary muscles and secondary muscles
- B. **Discuss the types of levers and applications, the resolution and composition of forces.**
 1. Describe the three types of body lever systems and give examples of each
 2. Solve problems related to force, torque, mechanical advantage, work, and power in a lever system
 3. Identify the lever classification of specific joints
 4. Resolve/compose force vectors, indicating rotatory and compressive/distractive forces
- C. **Discuss the biomechanics of muscle contractions.**
 1. Define and differentiate between isometric, concentric and eccentric muscle contractions
 2. Describe the relationship between the length of a muscle and the tension developed
 3. Discuss the relationship between force development and velocity of contraction
 4. Discuss the interaction between length-tension, angle of insertion, and lever arm length in torque development
- D. **Discuss the biomechanics and kinesiology of the hip joint.**
 1. Discuss the osteology and arthrology of the hip joint bones, ligaments and capsule
 2. Describe the osteokinematic and arthrokinematic motions for the hip joint

3. Describe femoral angle of inclination, anteversion and trabecular systems functional importance
 4. Name the primary and secondary muscles for all joint movements
 5. Describe muscle activity around the joint during standing posture and functional motion
 6. Describe the torque curve for each joint motion
 7. Discuss static and dynamic forces generated in the joint
 8. Discuss selected pathological muscle and joint conditions
- E. Discuss the biomechanics and kinesiology of the knee joint.**
1. Discuss the osteology and arthrology of the knee joint bones, ligaments and capsule
 2. Describe the osteokinematic and arthrokinematic motions for the knee joint.
 3. Discuss the function of the menisci, collateral and cruciate ligaments
 4. Describe the movement of the menisci during knee motions
 5. Identify the primary and secondary muscles for all joint movements
 6. Describe muscle activity around the joint during standing posture and functional motion
 7. Describe the torque curve for each joint motion
 8. Discuss static and dynamic forces generated in the joint
 9. Describe plica and their significance
 10. Discuss selected pathological muscle and joint conditions
- F. Discuss the biomechanics and kinesiology of the ankle and foot joints.**
1. Discuss the osteology and arthrology of the ankle and foot joints' bones, ligaments and capsule
 2. Describe the osteokinematic and arthrokinematic motions for the ankle and foot joints
 3. Discuss the function of the tibiotalar, subtalar and midtarsal joints to ankle joint motions, and the joint axes
 4. Identify the primary and secondary muscles for all joint movements
 5. Describe muscle activity around the joint during standing posture and functional motion
 6. Describe the structures that are involved in normal arch support of the foot
 7. Discuss selected pathological muscle and joint conditions
- G. Discuss the biomechanics and kinesiology of the shoulder joint.**
1. Discuss the osteology and arthrology of the shoulder joint bones, ligaments and capsule
 2. Describe the osteokinematic and arthrokinematic motions for the shoulder joint
 3. Describe normal and abnormal scapular tilting and rotation as related to normal and abnormal shoulder function
 4. Discuss the specific function of the rotator cuff muscles and scapular rotators during shoulder motions
 5. Identify the primary and secondary muscles for all joint movements
 6. Describe muscle imbalances in the shoulder muscles that can lead to impingement
 7. Describe the torque curve for each joint motion
 8. Discuss selected pathological muscle and joint conditions
- H. Discuss the biomechanics and kinesiology of the elbow and wrist joints.**
1. Discuss the osteology and arthrology of the elbow and wrist joints' bones, ligaments and capsule
 2. Describe the osteokinematic and arthrokinematic motions for the elbow and wrist joints
 3. Identify the primary and secondary muscles for all joint movements
 4. Describe the articulations and movement of the carpal bones during wrist motions
 5. Describe the torque curve for each joint motion
 6. Discuss selected pathological muscle and joint conditions
- I. Discuss the biomechanics and kinesiology of the hand.**
1. Discuss the osteology and arthrology of the hand's bones and ligaments
 2. Describe the osteokinematic and arthrokinematic motions for the hand
 3. Identify the primary and secondary muscles for all joint movements
 4. Describe the function of the extensor hood
 5. Describe functional position of the hand
 6. Describe the prehension patterns of the hand
 7. Describe the functional significance of nerve lesions that affect the hand
 8. Discuss selected pathological muscle and joint conditions
- J. Discuss the biomechanics and kinesiology of the spine.**
1. Describe joint structure at each level and how the structure determines available motion

2. Identify surface anatomy structures related to the spine
3. Identify primary and secondary movers
4. Identify joint ligaments and capsules
5. Discuss the structure and function of the intervertebral disc
6. Discuss the effect of loading and aging in the intervertebral disc
7. Based on signs and symptoms, determine pathological conditions of the spine and discs
8. Demonstrate appropriate exercises or positioning to reduce stress on the disc and spinal joints

K. Describe, examine and evaluate normal and pathological human locomotion.

1. Identify the six determinants of gait and determine their functional significance
2. Breakdown the normal gait cycle into the component phases
3. Describe the center of gravity movement during gait
4. Analyze kinetic and kinematic factors involved in gait including, joint positions, internal and external forces
5. Discuss the function of all major lower extremity muscles based on EMG recordings taken during the gait cycle

PT 412: LABORATORY OBJECTIVES

After the completion of the laboratory portion of this course, the student will be able to:

A. Examine and evaluate muscle strength, range of motion and sensation using manual muscle testing, goniometry and dermatome testing in a clinical context.

1. From a simulated patient's history determine the presence of any sensory loss or pain and record the dermatome location and level of the loss or the pain using an appropriate pain scale.
2. Perform an examination of a simulated patient; measure AROM and PROM and accurately record the measurements.
3. Evaluate a simulated patient's Resisted Isometrics and Myotome testing, and determine the need for individual manual muscle testing.
3. Determine the muscle grade for all upper extremity, lower extremity and trunk muscles and properly record it.
4. Examine a simulated patient and determine whether the identified muscle weakness is caused by a nerve root, peripheral nerve, or muscle lesion.
5. After examining a simulated patient with muscle weakness, list the specific muscles that may be weak.
6. Using the results of the examination, evaluate the cause of the problem and determine a physical therapy diagnosis.
7. Using the results of the examination and evaluation, determine an appropriate intervention for the patient.

B. Observe a subject's simulated pathological gait.

1. Observe a subject's simulated gait pattern and determine whether it is normal or pathological.
2. Recognize gait deviations caused by specific muscle weakness.
3. Recognize gait deviations caused by limitation of motion.
4. Recognize gait deviations caused by neurogenic dyskinesias.
5. Recognize gait deviations caused by leg length discrepancies.
6. Describe gait deviations caused by age.
7. Develop interventions for correcting gait deviations.

C. Analyze normal and abnormal upper and lower extremity motions

1. Compare scapular positioning between right to left side and note and differences in static positioning.
2. Track the motion of the scapula during elevation of the humerus and note and differences between right and left sides
3. During shoulder elevation determine the number of degrees of total motion was contributed by the scapulothoracic and the glenohumeral joints.
4. Measure the amount of glenohumeral motion available during elevation with the humerus internally rotated and externally rotated.
5. Observe the scapula position and describe the muscle impairment(s) that might contribute to a downwardly rotated scapula, depressed scapula, abducted scapula, adducted scapula, winged scapula and elevated scapula.
6. Demonstrate exercises that might be used to correct a scapula that is lacking upward rotation, posterior tilting and external rotation.
7. Demonstrate a stretching program for a person with a hip flexion contracture and discuss what influence anterior and posterior tilting of the pelvis may be used to enhance the stretching program.
8. Describe the effect hip flexor tightness on pelvic rotation, lumbar lordosis and hip and knee muscle activation during standing.

9. Describe the biomechanical strategy for strengthening the hip abductors in a patient who has excessive knee valgus during functional activities.
10. Demonstrate an open chain and closed chain stretch for the plantar fascia and heel cord.
11. Describe the differences in external torque on the knee during open chain and closed chain exercises such as a squat versus lifting an ankle weight in a seated position.
12. Analyze the concurrent movements of the hip, knee and ankle during a jumping motion from a squatting position and describe how the combination of motions affect the length tension relationships of the muscles involved.
13. Demonstrate the relationship between tibial motion and subtalar motion during a closed chain activity.
14. Compare and contrast muscle activity around the hip, knee and ankle during normal relaxed standing and in the presence of contractures at the hip, knee or ankle.

CURRICULUM PRACTICE MODEL

The above objectives contribute to the Curriculum Practice Model components of Patient/Client Management (all subcomponents of direct patient/client care) primarily with secondary emphasis in Professional Practice (communication and education).

Outline of Content (Syllabus):

DATE

	LECTURE	LABORATORY
JANUARY		
T 11	Basic Concepts & Lever Systems	PT 413—Fitness Evaluation
Th 13	Lever Systems	Muscle Biomechanics - <u>lecture</u>
T 18	Hip Biomechanics	Levers – Group A/B
Th 20	Hip Biomechanics	Levers – Group C/D
T 25	Hip Biomechanics	Hip Case – Group A/B
Th 27	Knee Biomechanics	Hip Case – Group C/D
FEBRUARY		
T 1	Knee Biomechanics	Knee Case – Group A/B
Th 3	No lecture	Knee Case – Group C/D
M 7 (1-2 pm)	Knee Biomechanics E221	
T 8	Ankle/Foot Biomechanics	Ankle Case – Group A/B
Th 10	Ankle/Foot Biomechanics	Ankle Case – Group C/D
T 15	PT 412 WRITTEN EXAMINATION – LOWER EXTREMITY	
Th 17	PT 412 PRACTICAL EXAMINATION – LOWER EXTREMITY	
T 22	Shoulder Biomechanics	Shoulder Case – Group A/B
Th 24	Shoulder Biomechanics	Shoulder Case – Group C/D
MARCH		
T 1	Shoulder Biomechanics	Shoulder Case – Group A/B
Th 3	Elbow Biomechanics	Shoulder Case – Group C/D
T 8	Wrist Biomechanics	Lower Arm Case – Group A/B
Th 10	Hand Biomechanics	Lower Arm Case – Group C/D
M-F 14-18	Spring Break	
T 22	Hand Biomechanics	Split lab: Group A/B 10-11; Group C/D 11-12
Th 24	PT 412 WRITTEN EXAMINATION - UPPER EXTREMITY	
T 29	PT 412: PRACTICAL EXAMINATION – UPPER EXTREMITY	
Th 31	Spine	Split lab: Group A/B 10-11; Group C/D 11-12
APRIL		
T 5	Spine	Spine Lab - Group A/B
Th 7	Spine & Pelvis	Spine Lab - Group C/D
T 12	WRITTEN EXAMINATION SPINE & PELVIS	
Th 14	Normal Gait	Normal Gait - Lab
T 19	Normal Gait	Normal Gait - Lab
T 21	Normal Gait	Normal Gait - Lab

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Th	26	Pathologic Gait	Pathologic Gait - Lab
T	28	Pathological Gait	Pathologic Gait - Lab

May 2 thru 5 Final Exam Week

TBA **PT 412 FINAL EXAMINATION**

GRADING COMPOSITION

Written exams

Upper extremity exam – 18%	A – 90%-100%
Lower extremity exam - 18%	B – 80%-89.95%
Spine exam - 10%	C – 76%-79.95%
Gait exam - 18%	<76% - unsatisfactory
Quizzes (5-6) – 10%	

Practical exams

Practical exam 1 - 13%

Practical exam 2 - 13%

An overall course grade of at least 76% and a minimum of 80% on each practical exam are required to successfully complete this course. A 76% score is passing for a lecture exam. Remediation is required for any written or practical exam score below 76% and 80%, respectively. Course grade will be determined by composite performance in written and practical exams. Unsatisfactory grades will be handled according to the guidelines set in the *Scholastic Standards and Professional Guidelines*.

Attendance

Attendance policy is in accordance with those listed in the *Scholastic Standards and Professional Guidelines*. Individual rescheduling of the taking of exams and the submission of assignments is at the discretion of the course coordinator. Students will be expected to don appropriate laboratory dress whenever this course is scheduled and in particular during laboratory practical exams.

Academic Integrity:

In accordance with the rules concerning scholastic dishonesty in the Code of Student Life (<http://und.edu/code-of-student-life/>) at the University of North Dakota, I affirm that I understand these rules and I agree to comply with them.

I will **NOT**:

- a) receive any additional information or assistance for any exam/assignment other than what was provided during class or approved tutor sessions
- b) copy from another student's test/assignment
- c) collaborate with or seek aid from another student who may have previously taken the exam/completed the assignment
- d) knowingly use, buy, sell, steal, or solicit in whole or in part the contents of any exam/assignment
- e) bribe another person to obtain information about any exam/assignment

Notice of Nondiscrimination

It is the policy of the University of North Dakota that no person shall be discriminated against because of race, religion, age, color, gender, disability, national origin, creed, sexual orientation, gender identity, genetic information, marital status, veteran's status, or political belief or affiliation and the equal opportunity and access to facilities shall be available to all. Concerns regarding Title IX, Title VI, Title VII, ADA, and Section 504 may be addressed to Donna Smith, Director of Equal Employment Opportunity/Affirmative Action and Title IX Coordinator, 401 Twamley Hall, 701.777.4171, und.affirmativeactionoffice@UND.edu or the Office for Civil Rights, U.S. Dept. of Education, 500 West Madison, Suite 1475, Chicago, IL 60611 or any other federal agency.

Disability Access Statement

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Contact me, Mark Romanick (mark.romanick@med.und.edu; 777-3668), to request disability accommodations, discuss medical information, or plan for an [emergency evacuation](#). To get confidential guidance and support for disability accommodation requests, students are expected to register with DSS at UND.edu/disability-services 180 McCannel Hall, or 701.777.3425.

Reporting Sexual Violence

If you or a friend has experienced sexual violence, such as sexual assault, domestic violence, dating violence or stalking, or sex-based harassment, please contact UND's Title IX Coordinator, Donna Smith, for assistance: 701.777.4171; donna.smith@UND.edu or go to UND.edu/affirmative-action/title-ix.

Faculty Reporting Obligations Regarding Sexual Violence

It is important for students to understand that faculty are required to share with UND's Title IX Coordinator any incidents of sexual violence they become aware of, even if those incidents occurred in the past or are disclosed as part of a class assignment. This does not mean an investigation will occur if the student does not want that, but it does allow UND to provide resources to help the student continue to be successful at UND. If you have been the victim of sexual violence, you can find information about confidential support services at UND.edu/affirmative-action/title-ix.

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COVID-19 Statement

All members of the University community have a role in creating and maintaining a COVID-19 resilient campus. There are several expectations that all community members, including students, are asked to follow for the safety of all: maintain physical distancing of at least 6 feet while in UND facilities, wear face coverings during interactions with others and in the classroom, wash their hands often and use hand sanitizer, properly clean spaces that they utilize, and if experiencing any symptoms, stay home and call their health care provider. Students electing not to comply with any of the COVID related requirements will not be permitted in the classroom, and may be subject to disciplinary action. We encourage all members of the University community choose to model positive behavior both on- and off-campus. Information regarding the pandemic and UND's efforts to create a COVID resilient campus is available on the COVID-19 blog (<http://blogs.und.edu/coronavirus/>). Please subscribe to stay up to date on COVID related information. Students who test positive for COVID-19 or are identified as a close contact are expected to immediately self-isolate/quarantine. If you have tested positive for COVID19 or have been placed in quarantine due to being identified as a close contact or travel we strongly recommend that you report the information to the Office of Student Rights and Responsibilities at 701.777.2664 or online at <https://veoci.com/veoci/p/w/ss2x4cq9238u>. Doing so will ensure students have the support they need to continue with their academic goals and to protect others.