1) Which of the following FBD of the shank during the foot contact phase of a vertical jump is correct given the FBD of the foot.

2) Assuming the lateral hamstring muscles is the only muscle able to produce a knee net joint moment, determine the resultant muscle force needed by the lateral hamstring muscle to generate a –30 Nm at the knee.
   a) 590 N  
   b) 600 N  
   c) 610 N  
   d) 1190 N  
   e) 3455 N

3) Determine NJM at the knee from the figure below. The horizontal distance from the knee joint to the shank CM and ankle weight is 0.12 m and 0.24 m, respectively.
   a) 7.2 Nm clockwise  
   b) 21.6 Nm counterclockwise  
   c) 28.8 Nm clockwise  
   d) 36.0 Nm counterclockwise  
   e) 64.8 Nm counterclockwise

4) Determine the thigh segment center of mass location given that the segment center of mass is located at 25% of segment length relative to the hip. The hip joint is located at (3, 9) and the knee is located at (3, 1).
   a) (3, 2)  
   b) (3, 7)  
   c) (2, 3)  
   d) (7, 3)  
   e) unable to determine center of mass location in x direction
5) Identify the correct total body CM position-time curve when moving from a **squat** to a **stand**

a) ![Diagram A]

b) ![Diagram B]

c) ![Diagram C]

d) ![Diagram D]

e) ![Diagram E]

6) Identify the correct total body center of mass velocity-time curve when moving from a **stand** to a **squat**

a) ![Diagram A]

b) ![Diagram B]

c) ![Diagram C]

d) ![Diagram D]

e) ![Diagram E]

7) Identify the correct vertical reaction force when moving from a **squat** to a **stand**

a) ![Diagram A]

b) ![Diagram B]

c) ![Diagram C]

d) ![Diagram D]

e) ![Diagram E]

**ANS:** (a)

8) Identify the correct total body center of mass acceleration-time curve from a **stand** to a **squat**

a) ![Diagram A]

b) ![Diagram B]

c) ![Diagram C]

d) ![Diagram D]

e) ![Diagram E]

**ANS:** (d)

9) What reference system would you choose to use when determining shear force at a joint?

a) Vertical and horizontal relative to gravity
b) **Parallel and perpendicular to the long axis of segment**
c) Posterior orientation relative to the gravity
d) Anterior orientation relative to the gravity
e) Medial and lateral orientation relative to the gravity
10) Determine the horizontal NJF at the knee under static conditions. The weight of the shank/foot system is 10N acting at the shank CM located .2m distal from the knee.

\[ NJFh = \ ? \]

- a) 173.21 N
- b) 100 N
- c) -173.21 N
- d) -100 N
- e) -273.21 N

11) Determine NJM at the knee

\[ Knee \ NJM \]

- a) 11 Nm clockwise
- b) 23.5 Nm clockwise
- c) 38.5 Nm counterclockwise
- d) 38.5 Nm clockwise
- e) 23.5 Nm counterclockwise

12) Determine the NJFh at the ankle acting on the foot segment

\[ NJFh = \ ? \]

- a) 50 N in anterior direction
- b) 50 N in posterior direction
- c) 150 N in anterior direction
- d) 90 N in posterior direction
- e) 110 N in anterior direction

Given this Free Body Diagram,

13) Which force(s) create a negative moment about the segment CM?

\[ NJMk \]

- a) Vertical component of cable force
- b) NJFh
- c) NJFh, NJFv, horizontal component of the cable force
- d) NJFh, NJFv, NJMk
- e) NJFh, NJFv, vertical and horizontal components of the cable force
14) Using the FBDs shown below question 15, which knee exercise will create the greatest anterior directed shear force at the knee? (a, b, c, d, or e) **ANS: c**

15) Using the FBDs shown below, which knee exercise will impose the greatest demand on muscles creating a knee flexor moment (-)? **ANS: a**

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**Use the FBD shown below, and the information provided to answer questions 16 - 23**

NJFkv = 1403.34 N, NJFkh = 63.97 N, NJMk = 238.73 Nm
W = 163.77 N
Thigh CM acceleration in horizontal = 1.59 m/s²
Thigh CM acceleration in vertical = 12.88 m/s²
Icm = 0.036 kg/m²
Thigh segment angular acceleration = -24.20 rad/s²

16) From the FBD above, what is the thigh segment angle relative to the right horizontal through the hip?  
   a) -31.43 degrees  
   b) -148.57 degrees  
   c) -58.57 degrees  
   d) -121.30 degrees  
   e) 21.12 degrees

17) What is the angle of the resultant NJF at the knee relative to the right horizontal through the knee?  
   a) 22.15 degrees  
   b) 67.85 degrees  
   c) 87.39 degrees  
   d) 2.61 degrees  
   e) 1.57 degrees

18) What is the NJFhh?  
   a) -63.97 N  
   b) -260.36 N  
   c) -150.99 N  
   d) -37.42 N  
   e) 150.99 N

19) What is the NJFhv?  
   a) -1239.66 N  
   b) -1024.47 N  
   c) -869.79 N  
   d) -979.18 N  
   e) -1188.37 N

20) What is the moment about the thigh CM created by the NJFkv?  
   a) 303.03 Nm  
   b) 294.70 Nm  
   c) 182.44 Nm  
   d) 8.31 Nm  
   e) 13.43 Nm
21) What is the moment about the thigh CM created by the NJFkh?
   a) 14.07 Nm
   b) 23.03 Nm
   c) 37.10 Nm
   d) 8.32 Nm
   e) 13.43 Nm

22) What is the moment about the thigh CM created by the weight of the thigh segment?
   a) 34.39 Nm
   b) 21.29 Nm
   c) -21.29 Nm
   d) 0 Nm
   e) -34.39 Nm

23) What is the Net Joint Moment at the hip?
   a) 0.87 Nm
   b) 0 Nm
   c) -90 Nm
   d) -0.87 Nm
   e) -222.95 Nm

24) If the Net Joint Moment at the hip is computed to be negative
   a) we assumed the NJM direction incorrectly
   b) the NJM acts counterclockwise
   c) knee NJM acts in the opposite direction
   d) the NJM= 0
   e) the system is static

The magnitude of the NJFkh is 400N acting in the direction drawn.

25) Which force(s) creates a moment in a clockwise direction about the thigh segment CM?
   a) NJFkv and W
   b) NJFhv and NJFkv
   c) NJFhh and NJFkh
   d) NJMk
   e) NJFkv, NJFhv, and NJMk

26) Which of the following statements is correct according to the above FBD?
   a) NJMk and the moment created by NJFkv act in different directions.
   b) NJMk and NJMh rotate the thigh segment in the same direction.
   c) Moments created by NJFkh and NJFkv rotate the thigh segment in a counterclockwise direction
   d) Moments created by NJFhh and NJFhv rotate the thigh segment in different directions
   e) NJMk has no effect on thigh segment rotation

27) From the FBD above, if the thigh segment is 150 degrees from the right horizontal reference through the knee. What is the compression force created by the resultant NJF at the knee joint?
   a) 900 N
   b) 1412.46 N
   c) 1046.41 N
   d) 1558.85 N
   e) 1912.44 N
28) From the FBD above, what muscle(s) are likely to be recruited to produce the $NJMh$?
   a) Hip adductors
   b) **Hip extensors**
   c) Hip flexors
   d) Hip internal rotator
   e) Hip external rotator

29) Which of the following statement(s) is true regarding a segment’s moment of inertia?
   a. the moment of inertia is the segment’s resistance to linear and angular acceleration
   b. **the moment of inertia is dependent on mass distribution about the CM**
   c. the moment of inertia changes during walking
   d. can be determined knowing the segments mass alone
   e. the moment of inertia is zero under static conditions

30) Which of the following statement is true regarding joint kinetic quantities?
   a. the net joint moment represents the net effect of all structures creating forces about a joint
   b. the net joint moment can be separated into perpendicular and parallel components to reflect compression
      and shear loading at a joint
   c. Net joint moments applied to adjacent joints are equal in magnitude but opposite in direction
   d. **Under static conditions, the magnitude of the net joint moment at the knee is equal to the ankle
      $NJM$ and the sum of the moments created by the resultant net joint forces acting at the ankle and
      knee.**
   e. the net joint force is the only cause of the segment CM linear acceleration