BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI - 620 024

(Accredited With A+ Grade By NAAC In The Third Cycle)

Department of Physical Education and Yoga

Bachelor of Physical Education (B. P. Ed)

EC-IV Theories of Sports and Major Games (21BPE44EA)

Sem. -IV

Credit-4

Unit-2
Biomechanical principles in coaching

Equilibrium

- Equilibrium is a state of body where neither the internal energy nor the motion of the body changes with respect to time. Let us try to understand the equilibrium of a rigid body.
- If we have to define equilibrium the simplest definition would be it is a point where the net external force, as well as torque acting on the body about COM or any other point, is zero. But to be more specific for a rigid body equilibrium means both rotational and translational equilibrium.
- Equilibrium is also classified as stable, unstable and neutral.

stable equilibrium

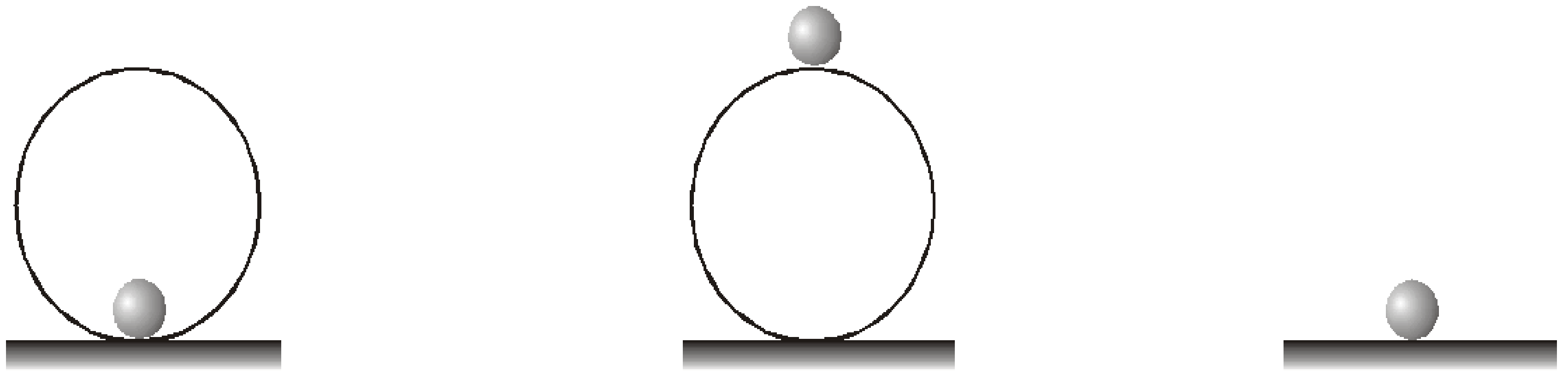
- Let's see what these mean. A stable equilibrium is one in which is the body is displaced from its equilibrium position then it tends to move towards that equilibrium point. For example, a ball kept at the bottom of a hemisphere.

Un stable equilibrium

- While in case of unstable equilibrium, if it is displaced from that point the body tends to move away from that point. Consider a ball kept at the top of a sphere. If we slide it, the ball tends to roll away from the topmost point.

Neutral equilibrium

- Similarly, in neutral equilibrium, the body neither moves towards nor away from the equilibrium point. For example, displace a ball kept on a horizontal surface slightly.



(a) Stable equilibrium (b) Unstable equilibrium (c) Neutral equilibrium.

Lever

- A lever is a simple machine consisting of a beam or rigid rod pivoted at a fixed hinge, or fulcrum, used to transfer a force to a load and usually to provide a mechanical advantage. A lever is a rigid body capable of rotating on a point on itself. On the basis of the locations of fulcrum, load, and effort, the lever is divided into three types.

Types of Lever

- There are three **types of levers**: **first-class, second class,** and **third class**. The difference between the three classes depends on where the force is, where the fulcrum is and where the load is.

- **1.** First Class Lever
- First-class levers have the fulcrum between the force and the load. In using a screwdriver to lift the lid from a paint tin you are moving the effort over a greater distance than the load. By having the fulcrum (the rim of the tin) close to the lid (the load) a larger force can be applied to the load to open the tin.
- By this means you are reducing the effort required, this is what first-class levers do best. Other examples of first-class levers are pliers, scissors, a crowbar, a claw hammer, a see-saw, and a weighing balance.
- In summary, in a first-class lever, the effort (force) moves over a large distance to move the load a smaller distance, and the fulcrum is between the effort (force) and the load. As the ratio of effort (force) arm length to load arm length increases the mechanical advantage of a first-class lever increases.
- Archimedes referred to a first-class lever in his famous quote "Give me one firm spot on which to rest (a fulcrum) and I will move the Earth"

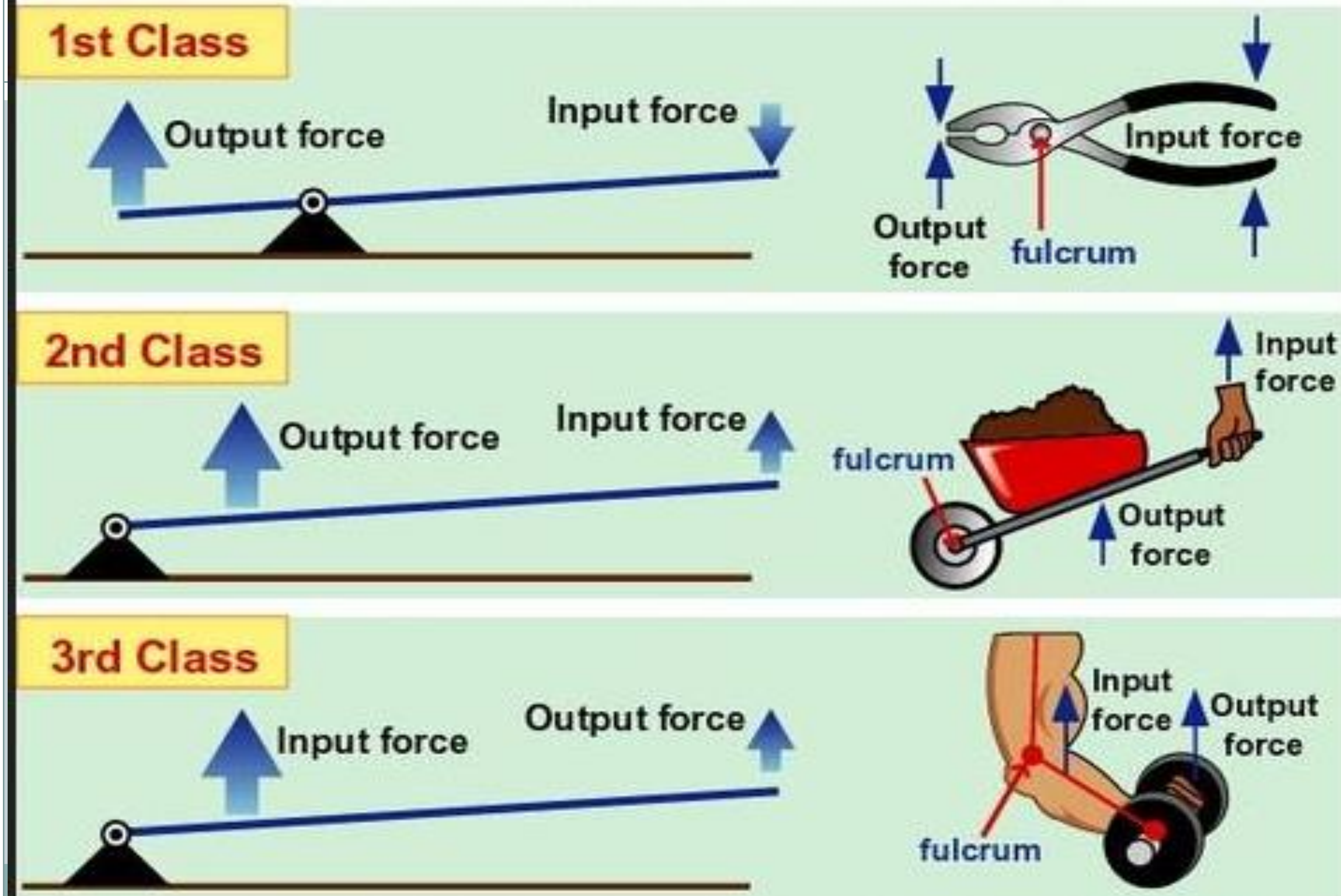
2. Second Class Lever

- In second class levers, the load is between the effort (force) and the fulcrum. A common example is a wheelbarrow where the effort moves a large distance to lift a heavy load, with the axle and wheel as the fulcrum.
- In a second class lever, the effort moves over a large distance to raise the load a small distance. As the ratio of effort (force) arm length to load arm length increases, the mechanical advantage of a second-class lever increases. In a wheelbarrow, the closer the load is to the wheel, the greater the mechanical advantage. Nutcrackers are also an example of a second-class lever.

3. Third Class Lever

- With third-class levers, the effort is between the load and the fulcrum, for example in barbecue tongs. Other examples of third-class levers are a broom, a fishing rod, and a woomera.
- In a third-class lever, the load moves further than the effort (force) and the mechanical advantage is low, which is why it's difficult to apply great force to the load. This can be an advantage by not squashing sausages on the barbecue!
- When you lift a load using your forearm you are using a third-class lever. Your biceps muscles are attached to the forearm just in front of the elbow. The load is on the hand, and the effort is between the fulcrum (elbow) and the load.

The 3 Classes of Levers



Motion

- We can define motion as the change of position of an object with respect to time. A book falling off a table, water flowing from the tap, rattling windows, etc., all exhibit motion. Even the air that we breathe exhibits motion! Everything in the universe moves. We live in a universe that is in continual motion.

Types Of Motion

- We might have noticed that different objects move differently. Some objects move in a curved path, some in a straight path and a few others in a different way. According to the nature of the movement, motion is classified into three types as follows:
- Linear Motion
- Rotary Motion
- Oscillatory Motion

Linear Motion

- In linear motion, the particles move from one point to another in either a straight line or a curved path. The linear motion depending on the path of motion, is further divided as follows
- Rectilinear Motion – The path of the motion is a straight line.
- Curvilinear Motion – The path of the motion is curved.
- A few examples of linear motion are the motion of the train, football, the motion of a car on the road, etc.

Rotatory Motion

- Rotatory motion is the motion that occurs when a body rotates on its own axis. A few examples of the rotatory motion are as follows:
- The motion of the earth about its own axis around the sun is an example of rotary motion.
- While driving a car, the motion of wheels and the steering wheel about its own axis is an example of rotatory motion.

Oscillatory Motion

- Oscillatory motion is the motion of a body about its mean position. A few examples of oscillatory motion are
- When a child on a swing is pushed, the swing moves to and fro about its mean position.
- The pendulum of a clock exhibits oscillatory motion as it moves to and fro about its mean position.
- The string of the guitar when strummed moves to and fro by its mean position resulting in an oscillatory motion.

- **Velocity**: The rate of change of displacement of a body is called velocity. It is denoted by V. The SI unit of velocity is m/s.
- **Uniform velocity**: The velocity of a body that does not change with time is called uniform velocity.
- **Acceleration**: The rate of change in velocity of the body is called acceleration. It is denoted by a. The SI unit of acceleration is m/s2m/s2.
- **Force**: The interaction that after applying to a body changes or tries to change the state of rest or a state of uniform motion of the body is called force. It is generally denoted by F.

Newton’s laws of motion

Three laws of classical mechanics that describe the relationship between the motion of an object and the forces acting upon it.

- A body in motion remains in motion or a body at rest remains at rest, unless acted upon by a force.
- Force equals mass times acceleration: F = m*a. Or, the rate of change of a body’s momentum equals the force acting upon it: $F = \Delta p/\Delta t$.
- For every action, there is an equal and opposite reaction.

History

- Sir Isaac Newton describes the three laws of motion in his 1687 book *Philosophiae Naturalis Principia Mathematica*. The *Principia* also outlines the theory of gravity. While the Theory of Relativity applies to objects moving near the speed of light, Newton’s laws work well under ordinary conditions.

Newton's First Law – Inertia

- **An object at rest remains at rest or an object in motion remains in motion at constant speed and in a straight line, unless acted upon by an unbalanced force.**
- Basically, the first law describes inertia, which is a body's resistance to a change in its state of motion. If no net force acts on a body (all external forces cancel out), then the object maintains constant velocity. A motionless object has a velocity of zero, while a moving body has a non-zero velocity. An external force acting upon an object changes its velocity.
- Here are some examples of Newton's first law:
- A dropped ball continues falling
- If you let go of a moving cart, it continues rolling (ultimately stopped by friction)
- An apple resting on a table does not spontaneously move

Newton's Second Law – Force

- **The rate of change of an object's momentum equals the force acting upon it or the applied force equal's an object's mass times its acceleration.**
- The two equations for Newton's second law are:
- F = m*a
- $F = \Delta p/\Delta t$
- Here, F is the applied force, m is mass, a is acceleration, p is momentum, and t is time. Note that the second law tells us that an external force accelerates an object. The amount of acceleration is inversely proportional to its mass, so it's harder to accelerate a heavier object than a lighter one. The second law assumes an object has constant mass (which is not always the case in relativistic physics).
- Here are examples of Newton's second law:
- It takes more effort moving a heavy box than a light one.
- A truck takes longer to stop than a car.
- It hurts more getting hit with a fast-moving baseball than a slow one. Each ball has the same mass, but the force depends on the acceleration.

Newton's Third Law – Action and Reaction

- **When one object exerts a force on a second object, the second object exerts and equal and opposite force on the first object.**
- For every action, there is an equal and opposite reaction. So, if set an apple on a table, the table pushes up on the apple with a force equal to the mass of the apple times the acceleration due to gravity. This can be difficult to visualize, but there are more obvious examples of Newton's third law:
- If you are wearing roller skates and you push another person wearing skates, you both move.
- A jet engine produces thrust. As the hot gases exit the engine, an equal force pushes the jet forward.


thank you