SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)
Coimbatore-35

DEPARTMENT OF BIOMEDICAL ENGINEERING

23BMT203 - BIOMEDICAL TRANSDUCERS AND SENSORS

UNIT III- MEASUREMENT OF PRESSURE & BLOOD FLOW

II Year/ IV Sem

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Direct Pressure Measurement

- ✓ Catheters type
- ✓ Diaphragm type

Indirect Pressure Measurement

- ✓ Doppler Ultrasound
- ✓ Applanation Method

Blood Flow Measurements

- ✓ Electromagnetic Blood Flow
- ✓ Ultrasonic Blood Flow

Ground Force Measurements

- ✓ Strain gauge type force plate
- ✓ Foot Force Distribution Measurements

Indirect Pressure Measurement

Indirect Pressure Measurement refers to the **non-invasive estimation of internal pressure** (like blood pressure or intracranial pressure) without inserting any device into the body.

Applanation Tonometry: Applies flat pressure over an artery to estimate internal pressure (e.g., intraocular pressure).

Doppler Ultrasound: Uses sound waves to estimate blood flow velocity and infer pressure changes.

Doppler Ultrasound of Blood Flow Measurement

Introduction to Doppler Ultrasound

Doppler ultrasound is a non-invasive diagnostic method that uses high-frequency sound waves to measure blood flow and pressure within the circulatory system.

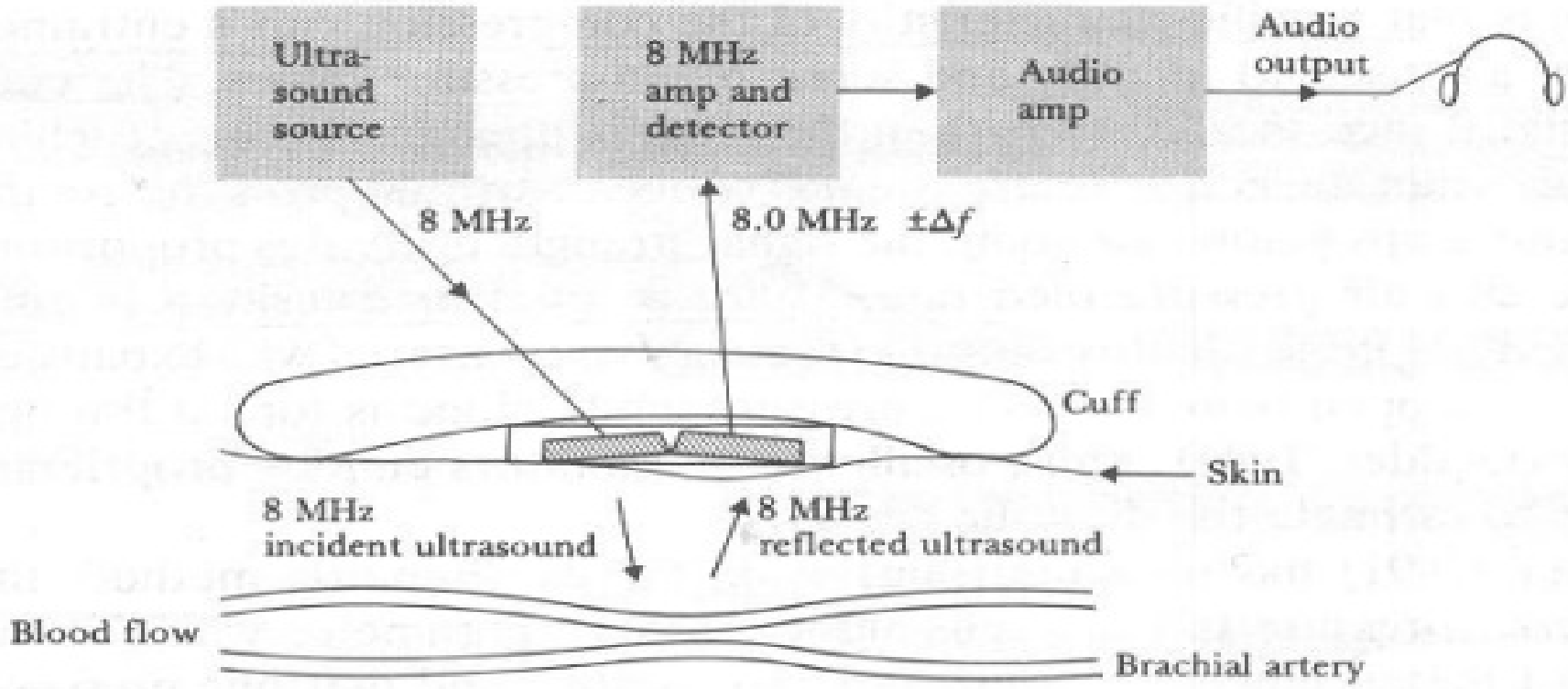
It is widely used in medical imaging to assess vascular conditions, detect blockages, and monitor hemodynamic parameters.

It helps assess the direction, speed, and pattern of blood flow in real time.

Basic Principles of Doppler Ultrasound

- Doppler ultrasound relies on the Doppler effect, which describes the change in frequency of a sound wave as it reflects off a moving object (e.g., red blood cells).

Doppler Ultrasound of Blood Flow Measurement



Doppler Ultrasound of Blood Flow Measurement

The frequency shift (Δf) is given by the equation:

$$\Delta f = \frac{2 f_0 v \cos\theta}{c}$$

where:

fo= transmitted ultrasound frequency

v= velocity of blood flow

0= angle between the ultrasound beam and blood flow direction

c= speed of sound in blood (~1540 m/s)

By analysing the Doppler shift, the velocity of blood flow can be determined.

Doppler Ultrasound of Blood Flow Measurement

- **Ultrasound waves** are emitted by a probe (transducer) into the body.
- These waves **bounce off moving red blood cells** in blood vessels.
- The **frequency shift** (Doppler shift) between transmitted and reflected waves is measured.
- The system **calculates flow velocity** based on this frequency shift.
- Flow is displayed as **waveforms or color maps** (in Color Doppler mode).

Advantages of Doppler Ultrasound

- **Non-invasive and safe**
- **Real-time blood flow monitoring**
- Can detect **blockages, narrowing, or abnormal flow**
- Useful for assessing both **arterial and venous circulation**
- No radiation exposure

Disadvantages of Doppler Ultrasound

- Operator-dependent accuracy
- Limited in **deep or obese tissues**
- Cannot directly measure pressure
- May miss **low-velocity flows** or **tiny vessels**

Applications of Doppler Ultrasound

- **Carotid artery assessment** for stroke risk
- **Peripheral artery disease** (PAD) diagnosis
- **Deep vein thrombosis (DVT)** detection
- **Fetal and placental blood flow monitoring**
- **Cardiac valve and chamber flow analysis**
- **Renal artery stenosis** evaluation