# MALLA REDDY VISHWAVIDYAPEETH

## SCHOOL OF PUBLIC HEALTH, EMERGING HEALTHCARE & TECHNOLOGY

Suraram X Roads, Jeedimetla,
Hyderabad-500055
Web: https://mrvv.edu.in/

**Program**

**Master of Science (M.Sc.)**

## ECHOCARDIOGRAPHY TECHNOLOGY (2D ECHO)

2025-2027

**MALLA REDDY VISHWAVIDYAPEETH**

**SCHOOL OF PUBLIC HEALTH, EMERGING HEALTHCARE & TECHNOLOGY**

**MASTER OF ECHOCARDIOGRAPHY TECHNOLOGY (2D ECHO)**

**COURSE STRUCTURE**

I year I semester

| S.NO | CATEGORY | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | MC | | Research Methodology and Biostatistics | 4 | - | - | 4 |
| 2 | MC | | Cardiac Anatomy, Physiology and Pathology of Cardiac Diseases | 3 | - | - | 3 |
| 3 | MC | | Fundamentals of Echocardiography | 2 | - | - | 2 |
| 4 | MC | | Basics of Medical and Surgical Treatments of Cardiac Diseases | 2 | - | - | 2 |
| 5 | MC | | Diagnostic Cardiovascular Imaging | 2 | - | - | 2 |
| 6 | MC | | Basics of Echocardiography - Practical | - | - | 4 | 2 |
| 7 | SI | | Clinical Postings - I | - | - | 16 | 8 |
| **TOTAL** | | | | **13** | **-** | **20** | **23** |
| **TOTAL CONTACT HOURS** | | | | **33** | | | |

**SEMESTER I**

RESEARCH METHODOLOGY AND BIOSTATISTICS L/T/P/C

4/-/-/4

**Learning objective:**

1. To understand fundamental concepts of research methodology, study designs, and formulation of research questions.
2. To develop knowledge of sampling techniques, measurement properties, and outcome measures in research.
3. To gain proficiency in biostatistical methods including descriptive, inferential statistics, and hypothesis testing.
4. To learn critical appraisal of research, evidence-based practice, and application of statistical software.

**Learning outcome:**

1. Ability to design and conduct appropriate research studies using suitable methodologies and sampling strategies.
2. Ability to analyze and interpret data using statistical tools such as t-tests, ANOVA, correlation, and regression.
3. Ability to critically evaluate published research and apply evidence-based findings in clinical practice.
4. Ability to effectively communicate research findings and utilize statistical software for data analysis.

RESEARCH METHODOLOGY

Introduction to research; Types of research; Defining a research question; Qualitative study designs; Quantitative study; Type I and type II bias; Study design: types

Case study, Case series, longitudinal cohort, Pre post design, Time series design, repeated measures design, Randomized control design.

Sampling design, calculating minimum sample size based on design

Measurement: Properties of measurement: reliability, validity, responsiveness, MCID.

Outcome measures: Use of outcome measures in rehabilitation research

Research Methods: Designing methodology, Reporting results, Type I and Type II

bias. Communicating research.

Evaluating published research: looking at the evidence

Introduction to evidence-based practice, evaluating evidence

Asking clinical questions

Translating of evidence into practice: strategies
Use of clinical practice guidelines, clinical pathways, prediction rules to inform

practice. BIOSTATISTICS

Descriptive Statistics and measurement variability; Inferential
Statistics; Comparison of group means: T test; Analysis of variance;
Multiple comparison tests
Parametric and non-parametric tests
Correlations
Regression
Analysis of frequencies: Chi square
Statistical measure of validity and reliability
Factorial Design analysis
Power analysis – Determining sample size, Epidemio logical Measures–Rate, Ratio, Proportion, Incidence and prevalence, Relative risk, Risk ratio, Odds ratio
Application of various statistical software.

**RECOMMENDED TEXT BOOKS**

1. Statistical methods in Biology by Bailey, N.T.J

2. Statistical methods by Gupta, S.P

3. Research Methodology by Kumar, R

# CARDIAC ANATOMY, PHYSIOLOGY AND PATHOLOGY OF CARDIAC DISEASES

L/T/P/C

3/-/-/3

**Learning Objective:**

1. To understand the detailed anatomy of the heart, great vessels, coronary circulation, and pericardium.
2. To explain cardiac physiology including cardiac cycle, conduction system, and hemodynamics.
3. To develop knowledge of the pathophysiology, clinical features, and management of major cardiac diseases.
4. To gain insight into congenital heart diseases, valvular disorders, and myocardial/pericardial diseases.

**Learning Outcome:**

1. Ability to describe normal cardiac structure, function, and circulatory mechanisms.
2. Ability to explain alterations in cardiac physiology in conditions such as hypertension, heart failure, and arrhythmias.
3. Ability to identify, classify, and interpret various cardiac diseases including coronary, valvular, and congenital disorders.
4. Ability to correlate clinical symptoms with underlying pathology and outline appropriate management approaches.

## UNIT 1 ANATOMY OF HEART AND GREAT VESSELS

- Anatomy and its subdivisions
- Blood and nerve supply of the heart
- Great vessels of the heart
- Structure of pericardium
- Structure of Aorta
- Venous drainage
- Aortic branches and vasculature
- Coronary arteries and veins

## UNIT 2 CARDIAC CYCLE

- Cardiac Cycle
- Conduction system of the heart
- Cardiac output and factors affecting cardiac output
- Sympathetic and Para Sympathetic innervations
- Systemic Circulation and Pulmonary Circulation

- Systemic hypertension and Pulmonary Hypertension
- Diastole, Ventricular filling and atrial diastole

## UNIT 3 DISEASES OF CORONARY ARTERIES, HEART FAILURE

- CAD and its types
- Causes, pathology and prevention of coronary artery diseases
- Symptoms and management of coronary artery disease
- Heart failure, Pathophysiology of Heart failure
- Heart failure medical management
- Heart failure surgical management
- Rheumatic Fever, Pathophysiology of Heart failure
- Coronary artery spasm and Angina

## UNIT 4 HEART FAILURE AND RHEUMATIC FEVER

- Disorders of valves, Valvular heart diseases
- Mitral valve diseases, its pathophysiology and its management
- Aortic valve diseases, its pathophysiology and its management
- Tricuspid valve diseases, its pathophysiology and its management
- Pulmonary valve diseases, its pathophysiology and its management
- Infective Endocarditis, Pathophysiology
- Management of Rheumatic fever
- Symptoms of Rheumatic fever

## UNIT 5 CONGENITAL HEART DISEASES AND DISEASES OF MYOCARDIUM

- Classification of Congenital heart diseases
- Diseases of Myocardium, Myocarditis, causes and management of myocarditis
- Pericarditis, causes and management of pericarditis
- Types of Cardiomyopathy, Pathophysiology and management
- Dilated Cardiomyopathy, Pathophysiology and management
- Hypertrophic Cardiomyopathy, Pathophysiology and management

- Diseases of the Pericardium
- Arrhythmogenic right ventricular cardiomyopathy

**REFERENCE:**


- The human heart by amar vasmani
- Cardiovascular Physiology by richard

# FUNDAMENTALS OF ECHOCARDIOGRAPHY

L/T/P/C

2/-/-/2

**Learning Objective:**

1. To understand the basic principles of ultrasound physics and instrumentation used in echocardiography.
2. To gain knowledge of transducers, ultrasound beam formation, and image optimization techniques.
3. To learn Doppler principles and various echocardiographic modalities including M-mode, 2D, and 3D echo.
4. To develop understanding of standard echocardiographic views, normal cardiac anatomy, and common artifacts.

**Learning Outcome:**

1. Ability to explain ultrasound principles, machine components, and safe use in clinical practice.
2. Ability to operate echocardiography equipment and optimize image acquisition effectively.
3. Ability to interpret Doppler findings and utilize different echocardiographic modalities appropriately.
4. Ability to identify normal cardiac structures, standard views, and differentiate artifacts from pathology.

## UNIT 1 – INTRODUCTION TO ECHOCARDIOGRAPHY

- History and evolution of echocardiography
- Basic principles of ultrasound physics
- Properties of ultrasound (frequency, wavelength, acoustic impedance, attenuation)
- Limitations of Ultrasound
- Interaction of ultrasound with tissues (reflection, refraction, scattering, absorption)
- Biological effects of ultrasound, attenuation with clinical significance
- Components of Echo machine and its function

## UNIT 2 – TRANSDUCERS AND PRODUCTION ULTRASOUND BEAMS

- Transducers and types of transducers
- Piezoelectric crystals, Transducer design, side lobes, phased array transducers, Fresnel

and Fraunhofer's zones.

- Manipulating the ultrasound beam, gain settings, depth, angle corrections, scale and sweep, colour and gray scale maps.
- Non cardiac ultrasound probes and its frequency
- Artifacts, Components of echo machine, Angle correction

## UNIT 3 – PRINCIPLES OF DOPPLER ECHOCARDIOGRAPHY

- Principles of Doppler echocardiography, velocity of blood in tissues
- Color flow imaging, doppler shift and its medical applications
- Blood flow velocity and gradients
- Pulsed wave doppler and continuous wave doppler

## UNIT 4 – ECHOCARDIOGRAPHIC MODALITIES

- M-mode echocardiography: principles, applications, normal values
- 2D echocardiography: image orientation, planes (parasternal, apical, subcostal, suprasternal)
- 3D echocardiography: advantages, limitations, clinical applications
- Contrast echocardiography: principles, agents, indications, safety

## UNIT 5 – ECHOCARDIOGRAPHIC VIEWS AND NORMAL VARIANTS

- Parasternal long and short axis views
- Apical 2, 3, 4, and 5 chamber views
- Subcostal (subxiphoid) views
- Suprasternal views
- Image optimization
- Chambers of the heart: morphology and normal dimensions
- Atria, ventricles, septa, and valves (mitral, aortic, tricuspid, pulmonary)
- Pericardium and great vessels (aorta, pulmonary artery, SVC, IVC)
- Echocardiographic correlation with cardiac anatomy
- Common anatomical variants seen in echo
- Reverberation, side lobe, mirror image, and dropout artifacts
- Recognition and differentiation from pathology

**REFERENCE:**


- Feigenbaum's Echocardiography- Eighth edition
- The Washington Manual of Echocardiography – South Asian edition

# BASICS OF MEDICAL AND SURGICAL TREATMENTS OF CARDIAC DISEASES

L/T/P/C

2/-/-/2

**Learning Objective:**

1. To understand the principles, indications, and procedures of common cardiac surgeries such as CABG and valve surgeries.
2. To gain knowledge of surgical and interventional management of congenital heart diseases.
3. To learn the classification, pathology, and management of aortic diseases and aneurysms.
4. To develop understanding of medical and surgical management strategies for ischemic, valvular, and congenital heart diseases.

**Learning Outcome:**

1. Ability to explain various cardiac surgical procedures, their indications, and associated complications.
2. Ability to differentiate between surgical and device-based interventions in congenital and valvular heart diseases.
3. Ability to outline management approaches for aortic diseases, ischemic heart disease, and revascularization procedures.
4. Ability to correlate clinical conditions with appropriate treatment options, including perioperative care and patient counselling.

## UNIT 1 DIFFERENT TYPES OF SURGERY

- Coronary artery bypass grafting (ON PUMP CABG)
- Uses, Procedure of CABG
- Post- operative care, results and complications of CABG
- Valvular heart disease and its types
- Mitral valve diseases and its surgical procedures
- Difference between the repair and replacement of valves
- Aortic valve diseases and its surgical procedures
- Tricuspid and pulmonary valve diseases and its surgical procedures
- CABG surgery and its complications
- Aortic aneurysm repair

## UNIT 2 SURGERY IN CONGENITAL HEART DISEASE

- Classification of congenital heart disease
- ASD closure / device / surgical
- Difference between device closure and surgical closure for CHD
- VSD closure / device / surgical
- TOF repair, uses, procedure and complications
- Glenn shunt procedure, uses and complications
- Fontan procedure, uses and complications
- Pulmonary artery banding procedure, uses and complications

## UNIT 3 DISEASES OF AORTA AND THORACIC AORTA

- Classification diseases of Aorta
- Types of aneurysms of aorta and its complications
- Standford classification
- DeBakey classification
- Procedure and surgery for aortic arch, management and their complications
- Procedure and surgery for ascending aorta, management and their complications
- Procedure and surgery for descending aorta, management and their complications
- Management and complications of diseases of aorta
- Marfan syndrome

## UNIT 4 MANAGEMENT OF IHD/ VALVULAR / CONGENITAL HEART DISEASES

- Ischemic heart disease, and their management and complications
- Invasive techniques used in ischemic heart diseases
- Coronary artery diseases and its complications
- Valvular heart disease, and their management and complications
- Procedure and surgery for mitral stenosis and mitral regurgitation and their complications, management
- Procedure and surgery for aortic stenosis and aortic regurgitation and their complications, management
- Procedure and surgery for tricuspid stenosis and tricuspid regurgitation and their complications, management

- Procedure and surgery for pulmonary stenosis and pulmonary regurgitation and their complications, management
- Procedure and surgery of IHD, CHD
- Revascularization procedures

## UNIT 5 CONGENITAL HEART DISEASES

- Management of ASD both in adult and pediatric patients
- Management of VSD both in adult and pediatric patients
- Management of PDA both in adult and pediatric patients
- Management of COA both in adult and pediatric patients
- Management of TGA both in adult and pediatric patients
- Management of DORV both in adult and pediatric patients
- Management of Hypoplastic left heart syndrome in pediatric patients
- Lifestyle modifications and emotional support and counselling for child with CHD

**REFERENCE:**


- Brounwakds heart diseases
- Cardiology: An illustrated textbook, kanuchatterjee, 2013 edition

# DIAGNOSTIC CARDIOVASCULAR IMAGING

L/T/P/C

2/-/-/2

**Learning Objective:**

1. To understand cardiac anatomy, physiology, and their correlation with imaging findings.
2. To gain knowledge of various cardiovascular imaging modalities including echocardiography, CT, MRI, and nuclear imaging.
3. To learn imaging techniques, physics, post-processing methods, and quantitative analysis.
4. To develop understanding of imaging applications in different cardiac pathologies along with quality and safety measures.

**Learning Outcome:**

1. Ability to correlate cardiac structure and function with findings from different imaging modalities.
2. Ability to select appropriate imaging techniques for diagnosing various cardiovascular conditions.
3. Ability to interpret imaging results in diseases such as ischemic heart disease, congenital disorders, and cardiomyopathies.
4. Ability to apply principles of radiation safety, quality control, and artifact recognition in clinical imaging practice.

## INTRODUCTION:

**Cardiac Physiology & Anatomy**: Cardiac cycle, ECG, heart structure, hemodynamics; ECG fundamentals and their correlation with imaging findings;
Overview of imaging modalities: strengths, weaknesses, clinical utility

## IMAGING TECHNIQUES:

Echocardiography (Transthoracic, Doppler, TEE, 3D/4D, Stress) Basic image acquisition, Doppler physics, quantitative analysis Advanced tools: strain imaging, contrast echo, artifact recognition

## CT (COMPUTED TOMOGRAPHY)

Coronary CT angiography protocols, dose metrics, interpretation of coronary artery disease Radiation safety: CTDI, DLP, field-of-view impacts, dose-saving techniques

## MRI (MAGNETIC RESONANCE IMAGING)

Physics: gating, cine sequences (bSSFP), T1/T2 mapping, phase-contrast imaging
Applications: viability, cardiomyopathy, myocarditis, congenital heart disease, angiography

## NUCLEAR IMAGING & PET/SPECT

Myocardial perfusion assessments, tracer principles, hybrid imaging applications
**Clinical Pathologies and imaging in**: Congenital heart disease; ischemic heart disease; valvular disorders; cardiomyopathies; pericardial and aortic diseases; masses; arrhythmias; device-related imaging, transplants

## IMAGING PHYSICS & POST-PROCESSING**:**

CT/MRI physics, 3D reconstruction techniques (MPR, MIP, volume rendering)

QUALITY & SAFETY**:** Radiation dose management, diagnostic accuracy, artifact avoidance

**RECOMMENDED TEXT BOOKS**

1. Case-Based Textbook of Echocardiography and Cardiac MRI- Editors: Anita Sadeghpour, Azin Alizadehasl, Anita M. Kelsey
2. Advanced Cardiac Imaging by Nieman, Gaemperli, Lancellotti, Plein
3. Cardiac Imaging in Clinical Practice- Editors: Dmitriy Kireyev & Judy Hung

# BASICS OF ECHOCARDIOGRAPHY - PRACTICAL

L/T/P/C

-/-/4/2

**Learning Objective:**

1. To develop hands-on skills in performing basic echocardiographic examinations.
2. To understand visualization of cardiac anatomy and physiology using echocardiography.
3. To learn assessment of chamber size, wall motion, valve function, and blood flow patterns.
4. To gain knowledge of measurement and interpretation of key parameters such as ejection fraction.

**Learning Outcome:**

1. Ability to perform basic echocardiographic scans and obtain standard views.
2. Ability to assess cardiac chambers, wall motion, and valve function accurately.
3. Ability to evaluate blood flow patterns using basic Doppler techniques.
4. Ability to calculate and interpret ejection fraction and correlate findings with cardiac function.

- Basic Anatomical and Physiological visualization in echo
- Chamber size and function
- Wall motion
- Valve function
- Blood flow patterns
- Ejection Fraction

**REFERENCE:**


- Brounwakds heart diseases
- Cardiology: An illustrated textbook, kanuchatterjee, 2013 edition

CLINICAL POSTINGS I L/T/P/C

-/-/16/8

**Learning Objective:**

1. To provide hands-on clinical exposure to cardiac anatomy, instrumentation, and diagnostic procedures.
2. To develop practical skills in performing and assisting TTE, TEE, ECG, TMT, and Holter monitoring.
3. To understand the clinical presentation, diagnosis, and management of various cardiac diseases.
4. To familiarize students with patient care and workflow in echo labs and cardiac ICU settings.

**Learning Outcome:**

1. Ability to perform basic cardiac diagnostic procedures under supervision.
2. Ability to operate and handle cardiac instruments and imaging equipment effectively.
3. Ability to recognize common cardiac conditions and correlate clinical findings with diagnostic results.
4. Ability to assist in patient management and demonstrate professional behavior in clinical environments.

- Cardiac Anatomy
- Instrumentations
- TTE
- TEE
- Cardiac Diseases and its

management Students should be posted

in,

- ECHO
- ECG
- TMT

- HOLTER
- CARDIAC ICU

I year II semester

| S.NO | CATEGORY | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | MC | | Advanced Electrocardiogram | 3 | - | - | 3 |
| 2 | MC | | TMT and Holter Monitoring | 2 | - | - | 2 |
| 3 | MC | | Valvular Heart Diseases in Echocardiography | 3 | - | - | 3 |
| 4 | MC | | Doppler Echocardiography | 2 | - | - | 2 |
| 5 | MC | | Stress Echocardiography | 2 | - | - | 2 |
| 6 | MC | | Advanced Electrocardiogram - Practical | - | - | 2 | 1 |
| 7 | MC | | Valvular Heart Diseases in Echocardiography - Practical | - | - | 2 | 1 |
| 8 | SI | | Clinical Postings - II | - | - | 16 | 8 |
| **TOTAL** | | | | **12** | **-** | **20** | **22** |
| **TOTAL CONTACT HOURS** | | | | **32** | | | |

**SEMESTER II**

## ADVANCED ELECTROCARDIOGRAM

L/T/P/C

3/-/-/3

**Learning Objective:**

1. To understand advanced ECG concepts including waveforms, intervals, and identification of abnormalities.
2. To develop knowledge of conduction disorders, heart blocks, and axis deviations.
3. To learn classification, mechanisms, and management of cardiac arrhythmias.
4. To gain insight into ECG changes in electrolyte imbalances, valvular, and congenital heart diseases.

**Learning Outcome:**

1. Ability to accurately interpret abnormal ECG findings including chamber enlargement and myocardial infarction.
2. Ability to identify and differentiate various heart blocks, bundle branch blocks, and conduction abnormalities.
3. Ability to recognize and manage common cardiac arrhythmias using ECG findings.
4. Ability to correlate ECG changes with electrolyte imbalances and structural heart diseases.

### UNIT 1 THE ABNORMAL ELECTROCARDIOGRAM

- Electrocardiogram waves, intervals and segments
- Electrocardiogram waves and its abnormalities
- The importance of chamber enlargement identifying in the ECG
- Left atrial and right atrial enlargement identifying in the ECG
- Left ventricular and right ventricular enlargement identifying in the ECG
- ECG finding in myocardial infarction.
- localization of ischemia/ infarction based on ECG
- primary and secondary T wave change
- Non-infarction q wave

### UNIT 2 HEART BLOCKS

- Conduction system in heart
- Axis deviation
- ECG findings in 1st degree AV BLOCKS
- ECG findings in 2nd degree AV BLOCKS
- ECG findings in 3rd degree AV BLOCKS or complete heart block
- Management of complete heart block
- Left bundle branch block
- Right bundle branch block
- Fascicular blocks.
- WPW syndrome and sick sinus syndrome

## UNIT 3 CARDIAC ARRHYTHMIAS

- Introduction and classification of cardiac arrhythmias
- Normal sinus rhythm
- ECG findings in tachyarrhythmia, bradyarrhythmia's
- Premature beats
- Supraventricular tachycardia
- Ventricular tachycardia
- Indications of Holter monitoring in cardiac arrhythmias.
- Cardioversion and Defibrillator
- Management of cardiac arrhythmia

## UNIT 4 ELECTROLYTE IMBALANCES IN ECG

- Specific electrolyte imbalances and importance of ECG
- Causes and ECG findings in hypercalcemia
- Causes and ECG findings in hypocalcaemia
- Causes and ECG findings in hypokalemia
- Causes and ECG findings in hyperkalemia
- Causes and ECG findings in Hypermagnesemia
- Causes and ECG findings in hypomagnesemia
- Long QT syndrome

- ECG in digoxin toxicity
- ECG changes in pericardial diseases

## UNIT 5 VALVULAR AND CONGENITAL HEART DISEASES IN ECG

- Causes and ECG findings in mitral valve disease
- Causes and ECG findings in aortic valve disease
- Causes and ECG findings in tricuspid valve disease
- Causes and ECG findings in pulmonary valve disease
- Importance of ECG in congenital heart disease
- ECG finding in atrial septal defect
- ECG finding in ventricular septal defect
- ECG finding in TOF
- ECG findings TGA
- Arrhythmias in congenital heart disease

**REFERENCE:**


- Leo Schamroth introduction to Electrocardiography clamber Narasimhan, Johnson Francis, Leo Schamorth
- Marriott's Practical Electrocardiography – Galen S. Wagner, David G Strauss

# TMT AND HOLTER MONITORING

L/T/P/C

2/-/-/2

**LEARNING OBJECTIVES:**

1. To understand the principles, physiology, and clinical significance of Treadmill Test (TMT) and Holter monitoring.
2. To learn proper patient preparation, equipment setup, and safe execution of TMT and Holter procedures.
3. To develop skills in monitoring, recording, and identifying ECG changes during exercise and ambulatory conditions.
4. To gain knowledge in interpretation of results, including arrhythmias, ischemic changes, and test limitations.

**LEARNING OUTCOMES:**

1. Perform TMT and Holter monitoring procedures accurately following standard protocols and safety guidelines.
2. Analyze and interpret ECG findings, including arrhythmias, ST changes, and heart rate variability.
3. Correlate diagnostic findings with clinical conditions such as ischemia, syncope, and palpitations.
4. Identify artifacts, limitations, and ensure quality control in cardiac diagnostic testing.

Introduction to Cardiac Diagnostic Tools: Overview of non-invasive cardiac diagnostic tests; Role of TMT and Holter monitoring in cardiovascular evaluation; Comparison with other methods (e.g., Echo, ECG, Event Recorder)

## TMT (Treadmill Test):

**Principles and Physiology;** Exercise physiology and myocardial oxygen demand; Bruce protocol and other protocols (Modified Bruce, Naughton); Indications and contraindications for TMT

**Equipment and Setup:** Treadmill system components; Patient preparation and safety; ECG lead placement during TMT

**Procedure and Monitoring:** Step-by-step procedure of conducting a TMT; Monitoring vital signs and ECG changes during exercise; Handling complications during the test

**Interpretation:** Criteria for positive/negative/indeterminate TMT; ST segment changes:

depression and elevation; Interpretation in special populations (e.g., females, elderly, LVH)

**Limitations and Artifacts:** False positives/negatives; Impact of medications; Motion and lead artifacts

# Holter Monitoring

**Principles:** Ambulatory ECG monitoring: indications and goals; Differences from Event Monitors and Loop Recorders

**Equipment and Setup:** Holter device components; Patient instructions and electrode placement; Diary/logbook use

**Data Acquisition and Analysis:** ECG recording over 24–72 hours; Data downloading and software analysis; Event correlation with symptoms

**Interpretation:** Identifying arrhythmias (AF, PVCs, SVT, pauses, blocks); Heart rate variability (HRV); Ischemic changes and silent ischemia

**Clinical Applications:** Syncope, palpitations, cryptogenic stroke; Risk stratification in post-MI and heart failure patients

**Recommended Text Books:**

1. Ambulatory Holter ECG Monitoring: Practical Insights by Taha Othmane & Omar El Hadj Othmane
2. Treadmill Stress Testing: Practical Insights by Taha Othmane
3. Ambulatory Electrocardiography: Holter Monitor Electrocardiography by E. K. Chung

## VALVULAR HEART DISEASES IN ECHOCARDIOGRAPHY

| | L/T/P/C |
|---|---|
| 1. Ability to identify and evaluate valvular heart diseases using echocardiographic findings.<br>2. Ability to assess severity and hemodynamic impact of valve lesions using standard echo parameters.<br>3. Ability to differentiate various types of valvular pathologies and correlate with clinical conditions.<br>4. Ability to perform and interpret pre- and post-operative echocardiographic assessments including prosthetic valve evaluation. | 3<br>/<br>-<br>/<br>-<br>/<br>3 |

**Learning Objective:**

1. To understand the anatomy, pathophysiology, and hemodynamics of valvular heart diseases.
2. To learn echocardiographic techniques for assessment of mitral, aortic, tricuspid, and pulmonary valve disorders.
3. To develop knowledge of quantitative parameters and scoring systems used in valve disease evaluation.
4. To gain insight into pre-operative and post-operative echocardiographic assessment of valvular interventions.

**Learning Outcome:**

## UNIT 1 MITRAL VALVE DISEASE

- Mitral valve apparatus
- Mitral stenosis, Etiopathogenesis, pathophysiology and hemodynamics.
- Echo assessment of mitral stenosis
- Wilkins score
- Role of TEE in assessment of mitral stenosis
- Classification of LAA clot
- Etiopathogenesis, pathophysiology, hemodynamics of mitral regurgitation
- parameters used in echo assessment of mitral regurgitation.
- Etiology of mitral regurgitation. Add a note on carpenter classification
- Parameters used in echo assessment of mitral regurgitation.
- Etiology of mitral regurgitation. Add a note on carpenter classification

## UNIT 2 AORTIC VALVE DISEASE

- Etiopathogenesis and hemodynamics of aortic stenosis
- Echo assessment of aortic valve
- Assessment of subvalvular, valvular and supravalvuar aortic stenosis
- Congenital aortic stenosis
- Echo assessment of aortic stenosis
- Role of stress echocardiography in low flow low gradient aortic stenosis
- Etiology of aortic regurgitation
- Echo assessment of aortic regurgitation
- Difference between acute and chronic aortic regurgitation

## UNIT 3 TRICUSPID VALVE DISEASE

- Echo assessment of tricuspid valve
- Echo assessment of tricuspid stenosis
- Functional and organic Tricuspid regurgitation
- Tricuspid regurgitation Etiopathophysiology and hemodynamics
- Echo assessment of tricuspid regurgitation

- Echo approach to Pulmonary artery hypertension
- Echo assessment of Right ventricle function
- Echo assessment of tricuspid valve prolapse
- Parameters used in echo for assessment of tricuspid regurgitation

## UNIT 4 PULMONARY VALVE DISEASE

- Discuss about embryology of pulmonary valve and its morphology.
- Echo assessment of pulmonary valve
- Discuss about m mode of pulmonary valve
- Discuss about classification of pulmonary stenosis
- Discuss about etiology of pulmonary stenosis
- Explain about infundibular and peripheral pulmonary stenosis
- Explain about echo findings in pulmonary regurgitation
- Explain pulmonary valvuloplasty
- Explain ross procedure

## UNIT 5 PRE- AND POST-OPERATIVE ASSESSMENT

- Echo assessment of pre- and post-operative PTMC
- Classification of prosthetic valve
- Echo assessment of prosthetic valve
- Post-operative assessment of MVR
- Post-operative assessment of AVR
- Echo assessment of prosthetic valve dysfunction
- Paravalvular leaks
- Post-operative echo assessment of tricuspid repair/ replacement
- post-operative echo assessment of pulmonary valvuloplasty

**REFERENCE:**

- Feigenbaum's Echocardiography, William F. Armstrong, Thomas Ryan, 2012, seventh edition.
- The Washington Manual of Echocardiography – South Asian edition

## DOPPLER ECHOCARDIOGRAPHY L/T/P/C

2/-/-/2

**Learning Objective:**

1. To understand the principles of Doppler echocardiography, including Doppler physics, modalities, and instrumentation.
2. To learn hemodynamic assessment using Doppler techniques in normal and abnormal cardiac physiology.
3. To develop knowledge of Doppler applications in valvular, ischemic, and cardiomyopathic heart diseases.
4. To gain insight into advanced Doppler techniques and their clinical applications in congenital and complex cardiac conditions.

**Learning Outcome:**

1. Ability to apply Doppler principles for accurate measurement of blood flow velocities and pressure gradients.
2. Ability to assess cardiac hemodynamics including diastolic function, cardiac output, and pulmonary pressures.
3. Ability to evaluate severity of valvular heart diseases using quantitative Doppler parameters.
4. Ability to interpret advanced Doppler findings in congenital heart disease, prosthetic valves, and myocardial function.

### UNIT I: FUNDAMENTALS OF DOPPLER ECHOCARDIOGRAPHY

- Principles of Doppler effect and its application in echocardiography
- Doppler equation and determinants of velocity measurement
- Types of Doppler modalities:
  - Continuous Wave (CW) Doppler
  - Pulsed Wave (PW) Doppler
  - Color Flow Doppler
  - Tissue Doppler Imaging (TDI)
- Instrumentation and technical aspects
- Nyquist limit, aliasing, and methods to overcome

## UNIT II: HEMODYNAMICS AND DOPPLER IN CARDIAC PHYSIOLOGY

- Normal intracardiac flow patterns
- Doppler assessment of pressure gradients (Bernoulli equation)
- Stroke volume and cardiac output measurements by Doppler
- Diastolic function assessment using transmitral, pulmonary vein, and tissue Doppler
- Pulmonary artery pressure estimation

## UNIT III: DOPPLER IN VALVULAR HEART DISEASE

- Doppler evaluation of:
  - Mitral stenosis and regurgitation
  - Aortic stenosis and regurgitation
  - Tricuspid and pulmonary valve lesions
- Quantitative methods: pressure half-time, continuity equation, proximal isovelocity surface area (PISA), regurgitant fraction, effective regurgitant orifice area
- Differentiation between mild, moderate, and severe valve disease

## UNIT IV: DOPPLER IN ISCHEMIC AND NON-ISCHEMIC HEART DISEASE

- Role of Doppler in acute coronary syndromes
- Regional wall motion abnormalities and Doppler strain techniques
- Tissue Doppler in myocardial function assessment
- Doppler in cardiomyopathies (hypertrophic, dilated, restrictive)
- Evaluation of diastolic dysfunction

## UNIT V: ADVANCED DOPPLER APPLICATIONS

- Doppler in congenital heart disease
- Stress Doppler echocardiography
- Contrast Doppler echocardiography
- Myocardial performance index (Tei index)
- Speckle tracking and strain imaging vs. tissue Doppler
- 3D echocardiography with Doppler integration

## UNIT VI: CLINICAL APPLICATIONS

- Doppler in prosthetic valve evaluation
- Doppler in intracardiac shunts (ASD, VSD, PDA)
- Doppler for assessment of right ventricular function

.

**REFERENCE:**


- Otto CM – *Textbook of Clinical Echocardiography*
- Feigenbaum's *Echocardiography*

# STRESS ECHOCARDIOGRAPHY

L/T/P/C

2/-/-/2

**Learning Objective:**

1. To understand the principles, indications, contraindications, and physiological basis of stress echocardiography.
2. To learn various stress methods including exercise, pharmacological, and pacing protocols.
3. To develop knowledge of image acquisition techniques, standard protocols, and optimization during stress conditions.
4. To gain insight into interpretation and clinical applications of stress echocardiography in cardiac diseases.

**Learning Outcome:**

1. Ability to perform and assist in different types of stress echocardiography safely and effectively.
2. Ability to acquire and optimize echocardiographic images at baseline, peak stress, and recovery phases.
3. Ability to identify ischemia, viability, and wall motion abnormalities using stress echo findings.
4. Ability to apply stress echocardiography in diagnosis, risk stratification, and management of cardiac conditions.

## UNIT I: FUNDAMENTALS OF STRESS ECHOCARDIOGRAPHY

- Principles of stress testing in cardiology
- Indications and contraindications of stress echocardiography
- Physiological basis of ischemia detection
- Hemodynamic response to stress
- Safety measures and patient monitoring during stress echo

## UNIT II: METHODS OF STRESS ECHOCARDIOGRAPHY

- Types of stress protocols:
  - Exercise stress echocardiography (treadmill, bicycle)
  - Pharmacological stress echocardiography (dobutamine, dipyridamole, adenosine)
  - Pacing stress echocardiography
- Endpoints and termination criteria
- Comparison of exercise vs pharmacological stress methods

## UNIT III: IMAGING TECHNIQUES AND PROTOCOLS

- Image acquisition at baseline, peak stress, and recovery
- Standard views and protocols (ASE/ESC guidelines)
- Contrast echocardiography for endocardial border delineation
- Optimization of imaging during tachycardia
- Role of 3D echocardiography in stress testing

## UNIT IV: INTERPRETATION OF STRESS ECHOCARDIOGRAPHY

- Normal wall motion response to stress
- Recognition of ischemia and viability:
  - Wall motion scoring system
  - Detection of new or worsening wall motion abnormalities
- Stress echo for myocardial viability (biphasic response, contractile reserve)
- Quantitative stress echocardiography – strain and tissue Doppler methods

## UNIT V: CLINICAL APPLICATIONS

- Stress echo in diagnosis of coronary artery disease (CAD)
- Risk stratification and prognosis in CAD
- Stress echo in valvular heart disease

- Stress echo in cardiomyopathy and pulmonary hypertension
- Stress echocardiography in special populations (athletes, post-PCI, post-CABG)

**REFERENCE:**


- Thomas JD, et al. – *Stress Echocardiography: A Practical Approach*
- Feigenbaum's *Echocardiography*
- Otto CM – *Textbook of Clinical Echocardiography*
- ASE & ESC Guidelines on Stress Echocardiography

# ADVANCED ELECTROCARDIOGRAM – PRACTICAL

L/T/P/C

-/-/2/1

**Learning Objective:**

1. To develop practical skills in recording and interpreting abnormal ECG patterns.
2. To understand identification and analysis of heart blocks, arrhythmias, and electrolyte imbalances through ECG.
3. To gain hands-on experience in Holter monitoring, cardioversion, and use of implantable cardiac devices.
4. To learn the role of ECG in valvular, congenital heart diseases, and patient management strategies.

**Learning Outcome:**

1. Ability to accurately record and interpret complex ECG abnormalities in clinical settings.
2. Ability to identify and differentiate various arrhythmias, heart blocks, and electrolyte-related ECG changes.
3. Ability to perform and assist in Holter monitoring, cardioversion, and device-based cardiac management.
4. Ability to correlate ECG findings with clinical conditions and contribute to patient care including lifestyle and treatment planning.

- The Abnormal Electrocardiogram
- Heart Blocks
- Cardiac Arrhythmias
- Electrolyte Imbalances in ECG
- Valvular and Congenital Heart diseases in ECG Holter Monitoring
- Lifestyle Modifications
- Medications And Cardioversion
- Implantable Devices

**REFERENCE:**


- Leo Schamroth introduction to Electrocardiography clamber Narasimhan, Johnson Francis, Leo Schamorth
- Marriott's Practical Electrocardiography – Galen S. Wagner, David G Strauss

# VALVULAR HEART DISEASES IN ECHOCARDIOGRAPHY – PRACTICAL

L/T/P/C

-/-/2/1

**Learning Objective:**

1. To develop hands-on skills in echocardiographic evaluation of valvular heart diseases.
2. To understand assessment of stenotic and regurgitant lesions of mitral, aortic, and tricuspid valves.
3. To gain practical knowledge of transesophageal echocardiography (TEE) and 3D echocardiography.
4. To learn image acquisition, optimization, and quantitative analysis in valvular assessment.

**Learning Outcome:**

1. Ability to perform echocardiographic assessment of major valvular heart diseases.
2. Ability to differentiate and evaluate severity of stenosis and regurgitation using echo findings.
3. Ability to assist in and interpret TEE and 3D echocardiographic studies.
4. Ability to correlate echocardiographic findings with clinical presentation for effective patient management.

- Aortic Stenosis / Regurgitation
- Mitral Stenosis and Regurgitation
- Tricuspid Stenosis / Regurgitation
- Tee
- Three - dimensional Echocardiography

**REFERENCE:**


- Leo Schamroth introduction to Electrocardiography clamber Narasimhan, Johnson Francis, Leo Schamorth
- Marriott's Practical Electrocardiography – Galen S. Wagner, David G Strauss

CLINICAL POSTINGS- II L/T/P/C

-/-/16/8

**Learning Objective:**

1. To provide advanced clinical exposure in ECG interpretation and echocardiographic techniques.
2. To develop practical skills in Doppler and stress echocardiography procedures.
3. To enhance understanding of valvular heart diseases and cardiac pathophysiology in clinical settings.
4. To train students in handling patients and diagnostic procedures in echo labs and cardiac ICU.

**Learning Outcome:**

1. Ability to perform and interpret advanced ECG and echocardiographic investigations under supervision.
2. Ability to apply Doppler and stress echocardiography techniques in clinical practice.
3. Ability to correlate clinical findings with diagnostic results in valvular and other cardiac diseases.
4. Ability to assist in patient management and demonstrate competence in multidisciplinary cardiac care environments.

- Advanced ECG
- Valvular heart diseases in echocardiography
- Doppler echocardiography
- Stress echocardiography
- Pathophysiology of cardiac

diseases Students should be posted in,

- ECHO
- ECG
- TMT
- HOLTER
- CARDIAC ICU

II year III semester

| S.NO | CATEGORY | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | MC | | Pediatric and Fetal Echocardiography | 3 | - | - | 3 |
| 2 | MC | | Heart Failure- I | 3 | - | - | 3 |
| 3 | MC | | Heart Failure Devices | 3 | - | - | 3 |
| 4 | MC | | Practical: Advanced Echocardiography | - | - | 4 | 2 |
| 5 | SI | | Clinical Postings - III | - | - | 16 | 8 |
| 6 | SEC | | AI in Healthcare: Foundation | 1 | - | - | 1 |
| **TOTAL** | | | | **10** | **-** | **20** | **20** |
| **TOTAL CONTACT HOURS** | | | | **30** | | | |

**SEMESTER III**

PEDIATRIC AND FETAL ECHOCARDIOGRAPHY L/T/P/C

3/-/-/3

**Learning Objective:**

1. To understand embryology, developmental anatomy, and physiology of the pediatric and fetal heart.
2. To learn echocardiographic techniques, views, and Doppler applications specific to neonates, children, and fetuses.
3. To develop knowledge of congenital heart diseases and their echocardiographic evaluation.
4. To gain insight into fetal cardiac imaging, diagnostic protocols, and clinical integration in perinatal care.

**Learning Outcome:**

1. Ability to perform and interpret pediatric and fetal echocardiographic examinations.
2. Ability to identify and classify congenital heart diseases using echocardiography.
3. Ability to assess fetal cardiac anatomy, circulation, and detect abnormalities accurately.
4. Ability to integrate echocardiographic findings into clinical decision-making, including pre- and post-operative evaluation.

## Basics of Pediatric Cardiology

- Embryology and developmental anatomy of the heart
- Normal anatomy of the neonatal and pediatric heart

## Echocardiographic Techniques in Pediatrics

- Echocardiographic windows in neonates and children
- Standard pediatric echo views (subcostal, apical, suprasternal, parasternal)
- Pediatric Doppler echocardiography (PW, CW, Color Doppler, Tissue Doppler)
- Use of high-frequency transducers
- Sedation and patient preparation in pediatric echo

## Congenital Heart Diseases (CHD)

- Classification of CHD (cyanotic & acyanotic)
- Echocardiographic features of:

o Atrial septal defect (ASD) o Ventricular septal defect (VSD) o Patent ductus arteriosus (PDA) o Tetralogy of Fallot (TOF)

o Transposition of the great arteries (TGA)

o Truncus arteriosus, TAPVC, Ebstein's anomaly, HLHS, etc.

- Role of echo in preoperative and postoperative evaluation of CHD

## FETAL ECHOCARDIOGRAPHY

**Foundations of Fetal Cardiac Imaging**: Cardiac embryology & development; Fetal circulation and hemodynamics; Imaging principles: 2D, Doppler, M-mode, and technical optimization

**Standard Scanning Views & Protocols:** Four-chamber, five-chamber, outflow tracts (3-vessel, 3-vessel trachea); Abnormal situs assessment (e.g., situs solitus/inversus); Crux evaluation: AV connections, septa, valves

**Advanced Imaging Technologies**: Doppler hemodynamics; STIC, 3D/4D imaging, Tissue Doppler Imaging (TDI); Emerging modalities (e.g., fetal cardiac MRI)

**Cardiac Anomalies**: Septal defects (ASD, VSD, AVSD); Conotruncal defects (e.g., TOF, TGA, DORV, truncus arteriosus); Valvular defects, arch anomalies (e.g., coarctation, interrupted arch); Hypoplastic left/right heart, single ventricle physiology; Heterotaxy syndromes, vascular anomalies (e.g., TAPVR, PAPVR)

**Arrhythmias & Acquired Pathology**: Fetal dysrhythmias and M-mode/Doppler diagnosis; Tumors, cardiomyopathies, heart failure, hydrops

**Diagnostic Workflow & Clinical Integration**: Indications for fetal echo and screening criteria; Reporting standards, quality assurance, and perinatal management integration; Case-based learning and critical thinking in assessment

**Recommended Text Books**


1. Fetal Echocardiography: A Practical Guide by Lindsey D. Allan, Andrew C. Cook, Ian C. Huggon
2. A Practical Guide to Fetal Echocardiography: Normal and Abnormal Hearts by Alfred Z. Abuhamad & Rabih Chaoui
3. Fetal Cardiology: A Practical Approach to Diagnosis and Management Editors: John Simpson, Vita Zidere, Owen I. Miller

# HEART FAILURE- I

L/T/P/C

3/-/-/3

## Learning Objective:

1. Understand the normal mechanisms of cardiac contraction, relaxation, ventricular performance, and myocardial oxygen demand.
2. Explain the major etiological factors and pathophysiological mechanisms responsible for heart failure, including ischemic, hypertensive, valvular, cardiomyopathic, congenital, and pediatric causes.
3. Develop competence in the clinical assessment of heart failure through appropriate history taking, physical examination, risk assessment, and relevant diagnostic evaluation.
4. Apply knowledge of cardiac physiology and heart-failure mechanisms to recognize, assess, and interpret heart failure in adults as well as infants.

## Learning Outcome:

1. Describe the cardiac cycle, Starling's law, preload, afterload, contractility, heart-rate–force relationship, and determinants of ventricular function.
2. Identify and explain the etiologies, progression, neurohormonal mechanisms, and ventricular-remodeling processes involved in heart failure.
3. Perform a systematic clinical assessment of patients with suspected or established heart failure and identify important signs of severity and prognosis.
4. Recognize the clinical features, mechanisms, and common causes of heart failure in infants, and correlate clinical findings with appropriate cardiac evaluation.

## UNIT 1: CARDIAC PHYSIOLOGY AND MYOCARDIAL FUNCTION

- Cardiac cycle: phases and hemodynamic events
- Determinants of ventricular performance: preload, afterload, and contractility
- Frank–Starling mechanism
- Myocardial wall stress
- Heart-rate–force relationship and myocardial contractile reserve
- Myocardial oxygen consumption and determinants of oxygen demand
- Assessment of left- and right-ventricular systolic function
- Evaluation of left- and right-atrial function

## UNIT 2: CAUSES AND ETIOLOGY OF HEART FAILURE

- Ischemic heart disease and ischemic cardiomyopathy
- Valvular heart disease
- Congenital heart disease
- Hypertensive heart disease
- Dilated, hypertrophic, and restrictive cardiomyopathies

## UNIT 3: PATHOPHYSIOLOGY AND VENTRICULAR REMODELING IN HEART FAILURE

- Heart failure as a progressive model
- Neurohormonal activation in heart failure
- Left-ventricular remodeling: mechanisms, patterns, and consequences

## UNIT 4: CLINICAL EVALUATION AND PROGNOSTIC ASSESSMENT OF HEART FAILURE

- Definition, classification, and clinical presentation of heart failure
- Physical examination and History taking in patients with heart failure
- Clinical risk stratification and prognostic assessment
- Diagnostic evaluation in heart failure

## UNIT 5: HEART FAILURE IN INFANTS: MECHANISMS AND CLINICAL FEATURES

- Etiology of HF in CHD
- Etiology of HF in Cardiomyopathy
- Clinical presentation and assessment

**REFERENCE:**


1. Heart Failure: A Companion to Braunwald's Heart Disease, 4th ed.
2. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine, 13th ed.
3. The ESC Textbook of Heart Failure

# HEART FAILURE DEVICES

L/T/P/C

3/-/-/3

## Learning Objective:

1. To understand the principles, indications, and applications of cardiac resynchronization therapy and mechanical circulatory support devices.
2. To develop knowledge of patient selection, implantation techniques, device programming, and follow-up care.
3. To understand hemodynamic assessment, patient monitoring, and echocardiographic evaluation during device therapy.
4. To recognize potential complications and apply appropriate clinical management principles.

## Learning Outcome:

1. Explain the indications, contraindications, and principles of CRT, IABP, VAD, TandemHeart, and ECMO.
2. Describe the basic implantation or insertion techniques and required patient evaluation.
3. Assess hemodynamic responses and monitor patients receiving mechanical cardiac support.
4. Identify common complications and demonstrate appropriate clinical and echocardiographic follow-up.

## UNIT 1: ASSESSMENT OF CARDIAC DYSSYNCHRONY FOR CRT

- Principles and mechanisms of electrical and mechanical dyssynchrony
- Atrioventricular, interventricular, and intraventricular dyssynchrony
- Echocardiographic assessment of mechanical dyssynchrony
- Recent echocardiographic indices of mechanical dyssynchrony

## UNIT 2: CARDIAC RESYNCHRONIZATION THERAPY: INDICATIONS AND GUIDELINES

- Patient selection for CRT
- Indications and contraindications for CRT
- Current guideline recommendations for CRT in heart failure

## UNIT 3: CRT IMPLANTATION, PROGRAMMING, AND FOLLOW-UP

- Pre-procedural patient assessment and preparation
- CRT device components and lead positions
- Principles and techniques of CRT implantation
- Peri-procedural complications and their prevention
- Device programming and various configurations for pacing
- Assessment of hemodynamic response and CRT response
- Various diagnostic follow-up after CRT

## UNIT 4: TEMPORARY MECHANICAL CIRCULATORY SUPPORT: IABP AND TANDEM HEART

- Intra-aortic balloon pump: mechanism, indications, contraindications, insertion techniques
- IABP timing, waveform interpretation, troubleshooting, and complications
- TandemHeart: components, mechanism, indications, contraindications, and insertion techniques
- Hemodynamic assessment, patient monitoring, and weaning during IABP and TandemHeart support
- Device-related complications and emergency management

## UNIT 5: ADVANCED MECHANICAL CIRCULATORY SUPPORT: VAD AND ECMO

- Principles and classifications of ventricular assist devices
- Indications, contraindications, and patient selection for VAD support
- VAD insertion techniques, hemodynamic assessment, patient evaluation, monitoring.
- Principles and types of extracorporeal membrane oxygenation: VA-ECMO and VV-ECMO
- Indications, contraindications, cannulation principles, and monitoring during ECMO
- Hemodynamic and echocardiographic assessment during VAD and ECMO support
- Recognition and management of common VAD- and ECMO-related complications
- Weaning, bridging strategies, and follow-up

**REFERENCE:**

1. Mechanical Circulatory Support: A Companion to Braunwald's Heart Disease, 2nd ed. — James K. Kirklin and colleagues
2. Clinical Cardiac Pacing, Defibrillation and Resynchronization Therapy — Ellenbogen, Wilkoff, Kay and Lau
3. Additional reference: 1st and 2nd recommended book in Heart Failure- I

## ADVANCED ECHOCARDIOGRAPHY- PRACTICAL

L/T/P/C

-/-/4/2

**Learning Objective:**

1. To develop advanced practical skills in performing paediatric, fetal, and 3D echocardiography.
2. To gain hands-on experience in echocardiographic evaluation of valvular, congenital, and systemic heart diseases.
3. To enhance proficiency in image acquisition, optimization, and interpretation in complex cases.
4. To integrate theoretical knowledge with clinical practice in advanced echocardiographic techniques.

**Learning Outcome:**

1. Ability to independently perform advanced echocardiographic procedures with appropriate techniques.
2. Ability to accurately interpret echocardiographic findings in complex cardiac conditions.
3. Ability to utilize 3D echocardiography and advanced modalities in clinical assessment.
4. Ability to correlate echocardiographic results with clinical findings for effective patient management.

- Fetal echocardiography

- Paediatric echocardiography
- Echo in systemic disorders and muscle disorders
- 3D echocardiography
- Echo in valvular heart diseases
- Echo in congenital heart diseases

**REFERENCE:**


- Feigenbaum's Echocardiography, William F. Armstrong, Thomas Ryan, 2012, seventh edition
- Comprehensive textbook of Echocardiography, Navin C Nanda, 2015, 1st edition

CLINICAL POSTINGS - III L/T/P/C

-/-/20/10

**Learning Objective:**

1. To provide comprehensive clinical exposure to advanced cardiac diagnostic and monitoring techniques.
2. To develop proficiency in performing and assisting with ECG, echocardiography, TMT, and Holter monitoring.
3. To enhance clinical skills in patient assessment and management in cardiac ICU settings.
4. To integrate theoretical knowledge with hands-on clinical practice in cardiology.

**Learning Outcome:**

1. Ability to independently perform basic cardiac diagnostic procedures under supervision.
2. Ability to interpret findings from ECG, echo, TMT, and Holter monitoring effectively.
3. Ability to assist in patient care and management in cardiac ICU environments.
4. Ability to demonstrate clinical competence and decision-making in real-world cardiology settings.

Students should be posted in,

- ECHO
- ECG
- TMT
- HOLTER
- CARDIAC ICU

## AI in Healthcare: Foundation

**Category:** Skill Enhancement Course (SEC) | **L-T-P:** 1-0-0 | **Credits:** 1

**Course Objectives**

- · Explain fundamental artificial intelligence concepts, machine learning principles, and

health data types without complex mathematics.

- · Identify and examine major clinical, diagnostic, public health, and operational AI use cases across the healthcare ecosystem.
- · Evaluate AI performance metrics, clinical validation strategies, algorithmic bias, and limitations of medical AI tools.
- · Apply ethical, legal, regulatory, and human-in-the-loop principles to ensure patient safety and privacy in AI deployment.
- · Demonstrate practical competency with no-code AI platforms to formulate a realistic solution for a discipline-specific healthcare challenge.

**Course Outcomes:** On completion, students will be able to:

- · **CO1:** Explain core AI concepts (machine learning, deep learning, NLP, generative AI) and their applications across healthcare systems in plain language.
- · **CO2:** Identify and describe major healthcare use cases of AI, including diagnostics, clinical decision support, drug discovery, public health surveillance, and hospital operations.
- · **CO3:** Critically evaluate AI tools by interpreting performance measures (accuracy, sensitivity, specificity) and recognizing bias and data-quality limitations.
- · **CO4:** Apply ethical, legal, and regulatory principles (privacy, consent, fairness, accountability, transparency) to healthcare AI implementation.
- · **CO5:** Use no-code AI tools responsibly to design and propose realistic AI solutions for discipline-specific healthcare challenges.

**Graduate Attributes Addressed:** GA1 (Disciplinary & Interdisciplinary Knowledge), GA2 (Critical Thinking & Problem Solving), GA3 (Digital & Technological Literacy), GA5 (Effective Communication), GA7 (Ethical Reasoning & Professional Integrity), GA9 (Entrepreneurship & Innovation Mindset), GA10 (Lifelong Learning & Self-Directed Growth)

**Unit I: Introduction to AI and Health Data**

- · Fundamental definitions and scope: What AI is and isn't; distinguishing AI, Machine Learning (ML), and Deep Learning (DL)
- · Basic principles of how machines learn patterns from data without advanced mathematics
- · Structure and taxonomy of health data: Electronic Health Records (EHR), medical imaging, genomics, and wearable sensor streams
- · Health data quality, data curation, and the principle of "garbage in, garbage out" in healthcare algorithms
- · **Practical/Hands-on Session:** Building and training a simple medical/healthcare image classifier using no-code platforms (e.g., Teachable Machine)

**Unit II: AI Applications Across Healthcare Domains**

- · Medical imaging applications in radiology, digital pathology, and ophthalmology
- · Clinical Decision Support Systems (CDSS), symptom checkers, and patient risk prediction models
- · Natural Language Processing (NLP) for unstructured clinical notes, voice recognition, and EHR documentation
- · Generative AI, LLMs, drug discovery workflows, public health surveillance, hospital operations, and AI-enabled telemedicine
- · **Practical/Case Demo Session:** Case demonstrations and critical group discussion on real-world AI deployment in clinical settings

**Unit III: Evaluating AI Performance, Bias, and Validation**

- · Interpreting performance metrics in plain clinical terms: accuracy, sensitivity, specificity, and false positives/negatives
- · Understanding overfitting, model generalizability across diverse patient populations, and performance degradation
- · Clinical validation frameworks, clinical trials for AI algorithms, and black-box explainability/interpretability
- · Identifying algorithmic bias, data representation gaps, and evaluating fitness-for-purpose
- · **Practical/Tutorial Session:** Critical appraisal exercise evaluating and critiquing a published AI tool's clinical claims

**Unit IV: Ethics, Law, and Healthcare AI Governance**

- · Patient data privacy, consent frameworks, and regulatory awareness (HIPAA, GDPR, and India's DPDP Act)
- · Algorithmic fairness, health equity, and preventing bias against vulnerable patient demographics
- · Clinical liability, accountability when AI systems err, and Software as a Medical Device (SaMD) regulatory oversight
- · Human-in-the-loop principles and maintaining practitioner oversight in automated healthcare decision-making
- · **Practical/Interactive Session:** Ethical dilemma role-play and decision-making scenario analysis

**Unit V: Responsible Practice and Capstone Project**

- · Prompt engineering techniques for generative AI tools (e.g., ChatGPT, Claude) in clinical and academic contexts

- · Managing AI hallucinations, fact-verification protocols, and ethical academic/professional use
- · Tracking fast-moving AI developments and future trajectories in medical technology
- · **Practical/Capstone Presentation:** Group formulation, design pitch, and presentation proposing a realistic AI solution to a domain-specific healthcare problem

**Recommended Readings**

***Key Textbooks & Reference Books***


1. **Topol, E.** (2019). *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*. Basic Books.
2. **Bohr, A., & Memarzadeh, K.** (Eds.). (2020). *Artificial Intelligence in Healthcare*. Academic Press.
3. **Agrawal, A., Gans, J., & Goldfarb, A.** (2018). *Prediction Machines: The Simple Economics of Artificial Intelligence*. Harvard Business Review Press.


***Regulatory Reports & Ethical Guidelines***


1. **World Health Organization.** (2021). *Ethics and governance of artificial intelligence for health: WHO guidance*. Geneva: World Health Organization.
2. **Ministry of Law and Justice, Government of India.** (2023). *The Digital Personal Data Protection Act, 2023 (DPDP Act)*. Gazette of India.
3. **U.S. Food and Drug Administration (FDA).** (2021). *Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD) Action Plan*.


***Online Interactive & No-Code Resources***

1. **Google Teachable Machine:**
   `[https://teachablemachine.withgoogle.com/](https://teachablemachine.withgoogle.com/)`
2. **Orange Data Mining (Visual Programming & Interactive Workflows):**
   `[https://orangedatamining.com/](https://orangedatamining.com/)`
3. **WHO / ITU Focus Group on Artificial Intelligence for Health (FG-AI4H) Resources:**
   `[https://www.who.int/initiatives/cih](https://www.who.int/initiatives/cih)`

## II year IV semester

| S.NO | CATEGORY | SUBJECT CODE | SUBJECT | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | RP | | Thesis/Research Project | - | - | 12 | 6 |
| 2 | MC | | Heart Failure II | 2 | - | - | 2 |
| 3 | MC | | Quality Control in Cardiovascular Imaging | 2 | - | - | 2 |
| 4 | MC | | Entrepreneurship in Cardiovascular Technology | 2 | - | - | 2 |
| 5 | SI | | Clinical Postings – IV | - | - | 16 | 8 |
| **TOTAL** | | | | **6** | **-** | **28** | **20** |
| **TOTAL CONTACT HOURS** | | | | **34** | | | |

## SEMESTER IV

THESIS/RESEARCH PROJECT

L/T/P/C

-/-/12/6

**Learning Objective:**

1. To develop the ability to independently design and conduct research in cardiovascular imaging.
2. To understand and apply appropriate research methodologies and biostatistical principles.
3. To enhance skills in critical analysis and interpretation of scientific data.
4. To promote innovation and evidence-based practice in cardiology and imaging.

**Learning Outcome:**

1. Ability to independently execute a research project from proposal to completion.
2. Ability to analyze and interpret data using scientific and statistical methods.
3. Ability to present research findings effectively in written and oral formats.
4. Ability to contribute to evidence-based clinical practice and advancements in cardiovascular imaging.

In project/thesis, the students should be able to:

- Independently conduct research
- Critically analyze findings with scientific methodology
- Contribute to evidence-based practice and innovations in cardiovascular imaging

HEART FAILURE L/T/P/C

2/-/-/2

**Learning Objective:**

1. Assess patients with acute and advanced heart failure using clinical examination, biomarkers, ECG, imaging, and hemodynamic findings.

2. Classify heart failure according to ejection fraction and explain the clinical importance of reduced, mildly reduced, preserved, and improved ejection fraction.

3. Explain the indications, patient-selection criteria, benefits, and limitations of CRT, ICD therapy, mechanical circulatory support, stem-cell therapy, and gene therapy.

4. Formulate an appropriate management and follow-up plan for patients with progressive or end-stage heart failure, including transplantation, palliative care, patient education, and shared decision-making.

**Learning Outcome:**

1. Assess patients with acute and advanced heart failure using clinical examination, biomarkers, ECG, imaging, and hemodynamic findings.

2. Classify heart failure according to ejection fraction and explain the clinical importance of reduced, mildly reduced, preserved, and improved ejection fraction.

3. Explain the indications, patient-selection criteria, benefits, and limitations of CRT, ICD therapy, mechanical circulatory support, stem-cell therapy, and gene therapy.

4. Formulate an appropriate management and follow-up plan for patients with progressive or end-stage heart failure, including transplantation, palliative care, patient education, and shared decision-making.

**UNIT 1: ASSESSMENT AND MANAGEMENT OF ACUTE HEART FAILURE**

- Epidemiology and major causes of acute heart failure
- Pathophysiology of acute decompensated heart failure
- Clinical presentation and classification of acute heart failure
- Diagnostic evaluation and hemodynamics
- Management principles

**UNIT 2: HEART FAILURE RELATIVE TO EJECTION FRACTION**

- Epidemiology and etiology

- Heart failure with reduced ejection fraction
- Heart failure with mildly reduced ejection fraction
- Heart failure with preserved ejection fraction
- Heart failure with improved or reversed ejection fraction
- Diastology of the heart
- Prognosis and clinical outcomes in different heart-failure phenotypes

**UNIT 3: DEVICE-BASED THERAPY AND MONITORING IN HEART FAILURE**

- Describe and explain management of ventricular dyssynchrony in HF
- Describe and explain management of Sudden cardiac death in HF
- CRT & ICD therapy in HF
- Role of mechanical circulatory support in HF
- Indication and patient selection in MCS

**UNIT 4: REGENERATIVE AND MOLECULAR THERAPIES IN CARDIOVASCULAR DISEASE**

- Describe stem-cell therapy
- Describe gene therapy

**UNIT 5: ADVANCED AND END-STAGE HEART FAILURE CARE**

- Definition and clinical features of advanced and end-stage heart failure
- Management of patients with end stage cardiac disease

**Recommended Textbooks**

1. Heart Failure: A Companion to Braunwald's Heart Disease, 4th ed.
2. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine, 13th ed.
3. The ESC Textbook of Heart Failure

## QUALITY CONTROL IN CARDIOVASCULAR IMAGING L/T/P/C

2/-/-/2

**Learning Objective:**

1. To understand the principles, standards, and importance of quality control in cardiovascular imaging.
2. To learn quality assurance practices across imaging modalities including echo, CT, and MRI.

3. To develop knowledge of accreditation systems, reporting standards, and regulatory requirements.
4. To explore the role of automation and AI in improving imaging quality and workflow efficiency.

**Learning Outcome:**

1. Ability to implement quality control measures in cardiovascular imaging procedures.
2. Ability to ensure standardized imaging protocols and maintain reporting accuracy.
3. Ability to evaluate and improve image quality across different imaging modalities.
4. Ability to apply quality assurance practices and contribute to safe, efficient clinical imaging services.

Introduction to Quality Control (QC): Definitions, quality domains (AHA), rationale, regulatory standards (accreditation: ACR, IAC)

Imaging Process QC: Patient selection, standardized protocols, reporting consistency

Modality-Specific QC – MRI: Protocol optimization, SNR/CNR metrics, QA programs

Modality-Specific QC – CT: Radiation dose audits, dose reduction strategies, multidisciplinary oversight

Modality-Specific QC – Echo: Reducing inter-observer variability, training interventions, EF measurement reproducibility

Accreditation and QA Systems: Accreditation benefits, reporting standards, dose registries and benchmarking

Automated QC Tools: AI in image quality prediction, automation in QC pipelines, integration in clinical workflow

Case Studies & Implementation: Quality failure analyses, best practice examples, implementation roadmaps

**RECOMMENDED TEXT BOOKS**

1. Quality and Safety in Imaging - Editors: Lluís Donoso-Bach & Giles W. L. Boland

2. Echocardiography: The Normal Examination and Echocardiographic Measurements by Bonita Anderson

ENTREPRENEURSHIP IN CARDIOVASCULAR TECHNOLOGY L/T/P/C

2/-/-/2

**Learning Objective:**

1. To understand the fundamentals of entrepreneurship and its application in cardiovascular technology.
2. To identify clinical needs and develop innovative solutions in cardiac imaging and healthcare.
3. To learn business modeling, financing, regulatory pathways, and intellectual property in medical technology.
4. To explore marketing strategies, scaling opportunities, and ethical considerations in healthcare entrepreneurship.

**Learning Outcome:**

1. Ability to develop innovative ideas addressing unmet needs in cardiovascular technology.
2. Ability to design viable business models and value propositions for healthcare solutions.
3. Ability to understand regulatory, financial, and market aspects of launching medical technologies.
4. Ability to apply entrepreneurial thinking ethically to improve access and quality in cardiovascular care.

Introduction to Entrepreneurial Mindset: Role of entrepreneurship in healthcare; lean startup and business model canvas; specifics for cardiac tech innovation

Identifying Clinical Needs & Innovation: Unmet needs in cardiovascular care; stakeholder insight (clinicians, patients); case studies from devices like echo tools, AI imaging

Business Modeling & Value Proposition: Value creation in CV tech; customer segmentation; designing offerings for cardiologists, imaging centers

Intellectual Property & Regulatory Landscape: IP strategies, patenting in cardiac imaging devices; navigating ISO/GMP, CE, FDA pathways for cardiovascular technologies

Financing and Market Development: Funding sources—grants, VC, angel; economic modeling for devices; reimbursement and health-economics in CV imaging

Marketing, Strategy, & Scaling: Competitor mapping in CV imaging; go-to-market options—hospitals, diagnostic centers; international expansion

Entrepreneurship Ethics & Policy: Ethical implications; equity in cardiovascular diagnostics; health policy dynamics affecting CV technology

**RECOMMENDED TEXT BOOKS**

1. Healthcare Entrepreneurship and Management: A Comprehensive Guide for Biomedical Engineers and Entrepreneurs by Arnab Chanda & Shubham Gupta
2. Medical Entrepreneurship: Trends and Prospects in the Digital Age- Editors: Lukman Raimi & Ibrahim Adekunle Oreagba

## CLINICAL POSTINGS – IV

L/T/P/C

-/-/16/8

**Learning Objective:**

1. To provide supervised, hands-on training in echocardiography and cardiovascular imaging techniques.
2. To enable application of theoretical knowledge in real-time clinical and patient care settings.
3. To develop proficiency in advanced echocardiographic techniques, interpretation, and reporting.
4. To enhance clinical skills in integrating imaging findings into patient management.

**Learning Outcome:**

1. Ability to independently perform standard echocardiographic examinations.
2. Ability to accurately analyze and report echocardiographic findings.
3. Ability to assist in advanced imaging procedures and clinical decision-making.
4. Ability to integrate diagnostic findings into comprehensive patient care.

- To provide supervised, hands-on clinical training in echocardiography and related cardiovascular imaging modalities.
- To enable students to apply theoretical knowledge in real-time patient care settings.
- To develop skills in advanced echocardiography techniques, interpretation, and reporting.
- The student should be able to independently perform, analyze, and report standard echocardiographic examinations, assist in advanced procedures, and integrate findings into patient management.