



MALLA REDDY VISHWAVIDYAPEETH

SCHOOL OF ALLIED AND PUBLIC HEALTH SCIENCES AND TECHNOLOGY

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Program

Master of Science (M.Sc.)

Cardiology Technology Non-Invasive (ECG, 2D ECHO, TMT & HOLTER)

2025

MALLA REDDY VISHWAVIDYAPEETH**SCHOOL OF ALLIED AND PUBLIC HEALTH SCIENCES AND TECHNOLOGY****MASTER OF SCIENCE (M.Sc.)****CARDIOLOGY TECHNOLOGY NON-INVASIVE (ECG,2D ECHO, TMT & HOLTER)****COURSE STRUCTURE****I year I semester**

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1	CNI27010101	Research Methodology and Biostatistics	4	-	-	4	40	60	100
2	CNI27010102	Cardiac Anatomy, Physiology and Pathology of Cardiac Diseases	3	-	-	3	40	60	100
3	CNI27010103	Fundamentals of Echocardiography	2	-	-	2	40	60	100
4	CNI27010104	Basics of Medical and Surgical Treatments of Cardiac Diseases	2	-	-	2	40	60	100
5	CNI27010105	Diagnostic Cardiovascular Imaging	2	-	-	2	40	60	100
6	CNI27010106P	Basics of Echocardiography - Practical	-	-	4	2	40	60	100
7	CNI27010107	Clinical Postings - I	-	-	16	8	40	60	100
TOTAL			13	-	20	23	280	420	700

I year II semester

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1	CNI27010201	Advanced Electrocardiogram	3	-	-	3	40	60	100
2	CNI27010202	TMT and Holter Monitoring	2	-	-	2	40	60	100
3	CNI27010203	Valvular Heart Diseases in Echocardiography	3	-	-	3	40	60	100
4	CNI27010204	Doppler Echocardiography	2	-	-	2	40	60	100
5	CNI27010205	Stress Echocardiography	2	-	-	2	40	60	100
6	CNI27010201P	Advanced Electrocardiogram - Practical	-	-	2	1	40	60	100
7	CNI27010203P	Valvular Heart Diseases in Echocardiography - Practical	-	-	2	1	40	60	100
8	CNI27010206	Clinical Postings - II	-	-	16	8	40	60	100
TOTAL			12	-	20	22	320	480	800

II year III semester

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1	CNI27010301	Paediatric and Fetal Echocardiography	3	-	-	3	40	60	100
2	CNI27010302	Echocardiography In Disease of Heart Muscles and Systemic Disorders	3	-	-	3	40	60	100
3	CNI27010303	Role of Echocardiogram in Interventional Studies	3	-	-	3	40	60	100
4	CNI27010304P	Practical: Advanced Echocardiography	-	-	4	2	40	60	100
5	CNI27010305	Clinical Postings - III	-	-	20	10	40	60	100
TOTAL			9	-	24	21	200	300	500

II year IV semester

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1	CNI27010401	Thesis/Research Project	-	-	16	8	40	60	100
2	CNI27010402	3D Echocardiography and Innovations	2	-	-	2	40	60	100
3	CNI27010403	Quality Control in Cardiovascular Imaging	2	-	-	2	40	60	100
4	CNI27010404	Entrepreneurship in Cardiovascular Technology	2	-	-	2	40	60	100
5	CNI27010405	Clinical Postings – IV	-	-	16	8	40	60	100
TOTAL			6	-	32	22	200	300	500

1.1 Post Graduate Programme

Sl. No.	Course	Duration	Eligibility for admission
1	M.Sc. Cardiology Technology Non-Invasive (ECG, 2D ECHO, TMT & HOLTER)	2 years	BSc in Cardiac Technology or equivalent examination of a recognized Indian University or a duly constituted Board with pass marks (50%).

1.2. Medium of Instruction:

English shall be the medium of instruction for all subjects of study and for examinations.

1.3. Duration of the Course

Duration details are mentioned under clause no. 1.1 of this booklet.

1.4 Examination Regulations

1.4.1 Attendance: 75% of attendance (physical presence) is mandatory.

Medical leave or other types of sanctioned leaves will not be counted as physical presence. Attendance will be counted from the date of commencement of the session to the last day of the closing of attendance before the final examination.

1.4.2 Internal Assessments:

a) Regular periodic assessment shall be conducted throughout the course. In each semester there will be **two one-hour internal assessments (15 marks each)** and a continuous assessment (10 marks). Thus, a total of 40 marks for the internal exam. (i.e. weightage for internal assessment shall be 40% of the total marks in each subject).

b) **Exam pattern for internal assessment** in each semester will be

(a) Short questions 3 nos. each carrying 5 marks (i.e. $3 \times 5 = 15$ marks). Two such internal examinations will be conducted.

(b) Continuous assessment of the student will be done. Students' overall attendance, performance in class, behaviour of the student, presentations, extra-curricular activities etc will be assessed. Continuous assessment carries 10 marks.

(d) Thus, a total of 40 marks for the internal examination. ($15 + 15 + 10 = 40$ marks). A candidate should secure a minimum of 40% marks in the internal assessment in each subject to be eligible to appear for the University examination

(e) For value added courses, only internal examination will be conducted. The assessment comprised of five assignments/presentations/case presentations each carrying 10 (i.e. $5 \times 10 = 50$ marks). Final examination will be for 50 marks with 5 questions each carrying 10 marks ($5 \times 10 = 50$ marks). The minimum pass is 40% marks.

1.4.3 University Examinations (External):

- a) University Examination shall be conducted at the end of every semester.
- b) A candidate who satisfies the requirement of attendance and internal assessment marks, as stipulated by the University shall be eligible to appear for the University Examination.
- c) Examination will be of 3 hours duration (for theory). The question pattern for those subjects without practical examination (60 marks) will be (a) Three essay questions out of which the student should answer 2 questions each carrying 10 marks (i.e. $2 \times 10 = 20$ marks) (b) Eight short note questions out of which the student should attempt six questions, each carrying 5 marks ($6 \times 5 = 30$ marks). (c) Ten very short questions each carrying 1 mark (i.e. $10 \times 1 = 10$ marks). Thus, a total of 60 marks.
- d) The question pattern for practical examination (a) Spotters/major practical/minor practical/case presenting/Viva/practical/log record.

The minimum pass for internal assessment is 40% and for the University Examination is 50%. i.e. a student should score a total of 50% (adding the internal and external examination) to pass in each subject.

SEMESTER I**RESEARCH METHODOLOGY AND BIOSTATISTICS**

L/T/P/C

4/-/-4

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, Epidemiological 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

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 Cardiomyopathies, Pathophysiology and management
- Dilated Cardiomyopathy, Pathophysiology and management
- Hypertrophic Cardiomyopathy, Pathophysiology and management
- Diseases of the Pericardium
- Arrhythmogenic right ventricular cardiomyopathy

Reference Text Books:

1. The human heart by amar vasmani
2. Cardiovascular Physiology by richard

FUNDAMENTALS OF ECHOCARDIOGRAPHY

L/T/P/C

2/-/-/2

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
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- Common anatomical variants seen in echo
 - Reverberation, side lobe, mirror image, and dropout artifacts
 - Recognition and differentiation from pathology

Reference Text Books:

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

BASICS OF MEDICAL AND SURGICAL TREATMENTS OF CARDIAC DISEASES

L/T/P/C

2/-/-/2

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
- Stanford 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 Text Books:

1. Braunwald's heart diseases
2. Cardiology: An illustrated textbook, Kanuchatterjee, 2013 edition

DIAGNOSTIC CARDIOVASCULAR IMAGING

L/T/P/C

2/-/-2

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

Reference 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

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

Reference Text Books

1. Brounwakds heart diseases
2. Cardiology: An illustrated textbook, kanuchatterjee, 2013 edition

CLINICAL POSTINGS I

L/T/P/C

-/-/16/8

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

Students should be posted in,

- ECHO
- ECG
- CARDIAC ICU

SEMESTER II

ADVANCED ELECTROCARDIOGRAM

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 Text Books:

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

TMT AND HOLTER MONITORING

L/T/P/C

2/-/-/2

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

3/-/-/3

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 supra-annular 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 Text Books:

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

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 Text Books:

1. Otto CM – *Textbook of Clinical Echocardiography*
2. Feigenbaum's *Echocardiography*

STRESS ECHOCARDIOGRAPHY

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 Text Books:

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

L/T/P/C

-/-/2/1

- 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 Text Books:

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

VALVULAR HEART DISEASES IN ECHOCARDIOGRAPHY – PRACTICAL

L/T/P/C

-/-/2/1

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

Reference Text Books:

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

- 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

SEMESTER III

PEDIATRIC AND FETAL ECHOCARDIOGRAPHY

L/T/P/C

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:
 - Atrial septal defect (ASD)
 - Ventricular septal defect (VSD)
 - Patent ductus arteriosus (PDA)
 - Tetralogy of Fallot (TOF)
 - Transposition of the great arteries (TGA)
 - 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

ECHOCARDIOGRAPHY IN DISEASE OF HEART MUSCLES AND SYSTEMIC DISORDERS

L/T/P/C

3/-/-/3

UNIT 1 CARDIOMYOPATHY

- Describe about Cardiomyopathy
- Discuss about the Classification of Cardiomyopathy
- Explain about Pathophysiology and Etiology
- Discuss about the Signs and symptoms of Myopathies.
- Describe about Idiopathic Cardiomyopathy – Diagnosis and hemodynamics
- Describe about the Diagnosis of Cardiomyopathies
- Describe about the Investigations – ECG, ECHO
- management of cardiomyopathy

UNIT 2 DISEASE OF PERICARDIUM

- Describe about the Pericardium
- Discuss about the pericardial and pleural effusion
- Explain about the pericardial effusion in echocardiogram- size
- Discuss about the causes and treatment
- Describe about Cardiac Tamponade
- Discuss about the Etiology and clinical features of tamponade
- Describe about the Constrictive Pericarditis – Diagnosis, Clinical findings & Treatment
- Explain about the treatment – Pericardiocentesis.

UNIT 3 DISEASES OF AORTA

- Describe about the Aorta – structure, size & position
- Explain about the Aortic dilatation and aneurysms
- Discuss about Classification and Diagnosis of aneurysm
- Discuss about Classification of Aortic dilatation
- Discuss about the parts of aorta
- Discuss about the aortic disease through echocardiography
- Explain about pre and post procedure evaluation
- Discuss about the treatment and Surgical management

UNIT 4 TRANS ESOPHAGEAL ECHO

- Describe about the introduction to TEE, history and development of TEE
- Explain about Indications and contraindications
- Discuss about the TEE probe and parts
- Explain about the Probe Position and views

- Explain about the basic principle of echocardiography
- Explain about the image acquisition and optimization techniques
- Explain about the Doppler imaging and color flow mapping during TEE
- Describe about the image interpretation

UNIT 5 ECHOCARDIOGRAPHY IN SYSTEMIC DISORDER

- Explain about the introduction to echocardiography in systemic disorder
- Describe about the rheumatologic disorders related to echocardiography
- Describe about the endocrine disorders in related to echocardiography
- Describe about the haematological disorders
- Describe about the autoimmune disorders
- Describe about the systemic infectious diseases
- Describe about the genetic disorders
- Explain about the protocols and measurement s in systemic disorders related to echocardiography

Reference Text Books:

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

ROLE OF ECHOCARDIOGRAM IN INTERVENTIONAL STUDIES

L/T/P/C

3/-/-/3

UNIT 1 INTRODUCTION TO INTERVENTIONAL PROCEDURE

- Discuss about coronary angiography
- Discuss about indication, contraindication and complications of coronary angiography
- Explain about IABP
- Explain about ventriculography
- Explain about the angioplasty procedure
- Aortography

UNIT 2 PERCUTANEOUS TRANSLUMINAL CORONARY ANGIOPLASTY

- Discuss about percutaneous trans luminal coronary angioplasty
- Explain about types of stents
- Explain about the complication of percutaneous trans luminal coronary angioplasty and its management
- Discuss about pre and post of evaluation of echo in percutaneous trans luminal coronary angioplasty
- Management of acute stent thrombosis
- Explain about role of echo in pericardiocentesis

UNIT 3 VALVULAR DISEASE

- Describe about the valvular heart disease and its classification
- Explain about echo guided trans septal puncture
- Discuss about role of echocardiography in PTMC
- Discuss about role of echocardiography in TAVI
- Discuss the role of echo in pre and post procedure
- Explain the role of TEE in valvular heart disease

UNIT 4 CONGENITAL HEART DISEASE

- Describe about congenital heart disease and its classification
- Explain about role of echo in ASD device closure
- Explain about role of echo in PDA device closure
- Explain role of echo in pulmonary valvotomy
- Discuss about role of echo in pre and post of evaluation in congenital heart disease
- Explain about TEE guided device closure

UNIT 5 PACING

- Describe about pacemaker
- Explain about classification of pacemaker
- Discuss about TPI and PPI pacing
- Describe about echo guided pacing
- Explain about post of echo evaluation of pacing.
- Explain about EP Study

Reference Text Books:

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

ADVANCED ECHOCARDIOGRAPHY- PRACTICAL

L/T/P/C

-/-/4/2

- Fetal echocardiography

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

Reference Text Books:

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

CLINICAL POSTINGS - III

L/T/P/C

-/-/20/10

Students should be posted in,

- ECHO
- ECG

- TMT
- HOLTER
- CARDIAC ICU

SEMESTER IV

THESIS/RESEARCH PROJECT

L/T/P/C

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

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

3D ECHOCARDIOGRAPHY AND INNOVATIONS

L/T/P/C

2/-/-/2

Fundamentals of 3D Echocardiography

- Evolution of echocardiography: 2D → Doppler → Strain → 3D/4D
- Physics and principles of 3D echocardiography

- Instrumentation and transducer technology (matrix array probes)
- Modes of 3D acquisition:
 - Real-time 3D
 - Multi-beat acquisition
 - Live 3D zoom
 - 3D color Doppler

Image Acquisition and Processing

- Patient preparation and positioning for 3D echo
- Acquisition protocols for transthoracic and transesophageal 3D echo
- Image optimization techniques (gain, sector width, frame rate)
- Post-processing and reconstruction (cropping, multiplanar reformatting, volume rendering)
- Artifacts in 3D echo and troubleshooting

Clinical Applications of 3D Echocardiography

- Valvular Heart Disease
 - Mitral valve anatomy and pathology (MR, MS, MVP, MV repair guidance)
 - Aortic valve evaluation (AS, AR, TAVR planning)
 - Tricuspid and pulmonary valve assessment
- Left Ventricular Function
 - 3D LV volumes and EF
 - Dyssynchrony assessment in heart failure
- Right Ventricular Function
 - 3D RV volumes and function
- Congenital Heart Disease
 - 3D imaging in septal defects and complex CHD

Innovations in Echocardiography

- Strain and Speckle Tracking Innovations
 - 3D strain imaging
 - Global longitudinal strain (GLS) in 3D

Reference Text Books:

1. Manual of 3D Echocardiography
2. Textbook of Three-Dimensional Echocardiography

QUALITY CONTROL IN CARDIOVASCULAR IMAGING

L/T/P/C

2/-/-/2

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

Reference 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

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

Reference 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

- 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.