

# **THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY**

**69, ANNA SALAI, GUINDY, CHENNAI - 600 032.**



**SYLLABUS**

**OF**

**M.Sc. ECHOCARDIOGRAPHY**

**ACADEMIC YEAR 2024 – 2025 SESSION ONWARDS**

# M.Sc Echocardiography

FIRST YEAR

Course content (Syllabus) Theory

Paper I: Embryology and ultrasound Physics

Total hours: 47 Hrs

| Unit No | Unit title                                 | Unit objectives | Content                                                                                                                                                                                                                                                                    | Hours | Method of evaluation     |
|---------|--------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------|
|         | Orientation and introduction to the course |                 |                                                                                                                                                                                                                                                                            | 1     |                          |
| 1       | Early development of embryo                |                 | mitosis, -meosis<br><br>-Oogenesis<br><br>-spermatogenesis<br><br>-fertilization-formation of germ layers-<br>formation of embryonic disc-placental<br>formation                                                                                                           | 8     | Sessional<br>examination |
| 2       | Early blood vessel formation               |                 | Intra embryonic blood vessel - extra<br>embryonic<br><br>blood vessel                                                                                                                                                                                                      | 2     | Sessional<br>examination |
| 3       | Development of the heart                   |                 | Heart tube formation<br><br>-cardiac loop formation<br><br>-interatrial septum formation,<br><br>-interventricular septum formation -<br>atrial formation<br><br>-ventricular formation<br><br>-formation of the<br><br>cardiac valves -formation of the great<br>systemic | 10    |                          |

|   |                          |                                        |                                                                                                                                                                                                                                                                                                                                                      |    |                       |
|---|--------------------------|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----------------------|
|   |                          |                                        | veins-aortic arch<br>formation                                                                                                                                                                                                                                                                                                                       |    |                       |
| 4 | Basics of ultrasound     | Ultrasound physics and instrumentation | Physical principles,<br>-The transducer,<br>Imaging by ultrasound –Image optimization<br>& equipments<br>-Signal processing<br>-Tissue harmonic imaging-Artifacts                                                                                                                                                                                    | 3  | Sessional examination |
| 5 | Doppler Echocardiography |                                        | Principles of Doppler ultrasound<br>-Doppler formats<br>-CF imaging<br>-Doppler artifacts<br>-Tissue Doppler imaging<br>-Doppler application<br>-Speckle tracking<br>- Tissue characterization                      -The digital echo Lab –Storage & retrieval of echo Images, Post study processing and approaches to AFI,-Biological Effects of US | 10 | Sessional examination |

|        |                                                            |                                |                                                                                                                                         |   |                          |
|--------|------------------------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|---|--------------------------|
| 6      | Specialized<br>Echocardiographic<br>Techniques and methods |                                | Hemodynamics,<br>Use of echo to assess cardiac<br>hemodynamics<br>and guide therapy<br>-Evaluation of 3D Echo<br>Transducer technology, | 6 | Sessional<br>examination |
| 6<br>A | Basics of 3D US                                            |                                | Beam forming and rendering<br>3d quantification, 3d<br>examination protocol and<br>approach                                             |   |                          |
| 6<br>B | TEE                                                        |                                | Instrumentation and<br>Examination-TEE views-<br>complication and safety<br>consideration                                               |   |                          |
| 7      | Echocardiographic<br>examinations                          | Cardiac<br>chambers            | LV systolic Function, LV<br>diastolic Function, LA, RA RV<br>Function, Echo in ICU,<br>operative, pre-operative<br>application          | 7 | Sessional<br>examination |
|        |                                                            | Stress<br>Echocardiogr<br>aphy | Methodology<br>-Pharmacological<br>stress echo-Interpretation<br>-Stress echocardiography in<br>valvular heart Disease                  |   |                          |

**Paper II: Clinical cardiology****Total hours: 47**

| <b>Unit No</b> | <b>Unit Title</b>                         | <b>Unit Contents</b>                                                                                                                                                                                                                                                                                                                           | <b>Hours</b> | <b>Method of Evaluation</b> |
|----------------|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------|
| 1              | Introduction and basics                   | -                                                                                                                                                                                                                                                                                                                                              | 1            | Sessional examination       |
| 2              | Basic anatomy and physiology of the heart | Anatomy of the heart<br>-Lymphatic system ,Arterial and venous supply of the heart<br><br>-Conduction system and basic electrophysiology                                                                                                                                                                                                       | 3            | Sessional examination       |
| 3              | History and symptoms                      | Importance of history taking.<br><br>-Causes of cardinal symptoms(Cardiovascular and non cardiovascular)- Assessment:-NYHA functional Classification -CCS functional classification -Specific activity scale -Chest Pain, Dyspnea, Shortness of breath, Palpitation, Fatigue, Syncope, Other symptoms: Hemoptysis, Hoarseness, Cyanosis, Fever | 10           | Sessional examination       |
| 4              | General Examination                       | Facial appearance -Gesture and signs -<br><br>Oral cavity-Skin, Extremities-Peripheral edema                                                                                                                                                                                                                                                   | 4            | Sessional examination       |
| 5              | Arterial pulse                            | Definition –Genesis -Wave pattern- Examination of arterial pulse- Characteristic features of pulse in<br><br>common clinical conditions                                                                                                                                                                                                        | 3            | Sessional examination       |
| 6              | Measurement of Blood pressure             | Definition -Components and determinants of arterial blood pressure - Hypertension – Cause, mechanism and complications                                                                                                                                                                                                                         | 2            | Sessional Examination       |
| 7              | Jugular venous pressure                   | Examination -Analysis-Abnormalities                                                                                                                                                                                                                                                                                                            | 2            | Sessional                   |

|     |                                         |                                                                                                                                                                    |    |                       |
|-----|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----------------------|
|     |                                         |                                                                                                                                                                    |    | Examination           |
| 8   | Cardiovascular system examination       | Inspection and palpation of the Precordium, Percussion                                                                                                             | 2  | Sessional examination |
| 9   | Cardiac auscultation                    |                                                                                                                                                                    | 4  | Sessional examination |
| 9A  | Heart sounds                            | Principle and Techniques First Heart sound<br><br>Second heart sound Diastolic and systolic sounds Prosthetic valve sounds<br><br>Extra cardiac sounds             |    |                       |
| 9B  | Heart Murmurs                           | Definition -Mechanism<br>Characteristics -Systolic murmur<br>Diastolic murmur -Continuous murmur                                                                   |    |                       |
| 10  | Basic investigation                     | Complete Hemogram, Liver, Thyroid and Renal Function test, Blood sugar, Serology testing.                                                                          | 3  | Sessional Examination |
| 10A | Chest X-ray                             | Normal chest X-ray<br>Views of Chest X Ray and Interpretation<br>Lung and Pulmonary vasculature Cardiac size<br>Abnormal Densities and lucency Cardiac malposition |    |                       |
| 10B | Evaluating chestX-ray in heart disease: | Lungs and pulmonary vasculature<br><br>Cardiac chambers and Great vessels<br>Pleura and pericardium<br>Implantable devices and other postsurgical findings         |    |                       |
| 11  | Clinical Electrocardiogram              | Advanced ECG- ECG findings in Various cardiac Diseases -Clinical issues in ECG interpretation                                                                      | 4  | Sessional examination |
| 12  | Cardiovascular pharmacology             | Mechanism of action-Indications, Dosage -Precautions of cardiovascular Drugs, Atropine- Lidocaine - Procainamide- Verapamil and                                    | 10 | Sessional examination |

|  |  |                                                                                                                                                                                                                                                                                                                           |  |  |
|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
|  |  | diltizem-Adenosine-Magnesium-<br>Sodium Bicarbonate, Morphine-<br>Calcium chloride -Dopamine-<br>Dobutamine- Isoproterenol -<br>Amrinone<br>Sodium Nitroprusside -B-<br>blockers:propranolol, Metoprolol,<br>Atenolol-<br>Diuretics -Thrombolytic<br>agents: Streptokinase,Urokinase,<br>Tenecteplase and Reteplase(rtpa) |  |  |
|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|

### Paper III: Echocardiography for Ischemic and valvular heart disease

Total hours: 57hrs

| Unit No | Unit title                                 | Unit objectives                               | Content                                                                                                                                                                                         | Hours | Method of evaluation  |
|---------|--------------------------------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------|
| 1       | Orientation and introduction to the course |                                               |                                                                                                                                                                                                 | 1     | Sessional examination |
| 2       | Ischemic Heart Disease                     | Echo cardiography and Coronary artery disease | Understanding Coronary circulation, -Pathophysiology of coronary artery syndrome -wall motion scoring,-Detection and quantification of RWMA -Global ventricular function,-myocardial infarction | 3     | Sessional examination |
| 2A      | Echo assessment Coronary arteries          |                                               | Morphology and coronary flow reserve by TTE and TEE - Visualization of coronary arteries- Distal coronary Flow and coronary flow reserve                                                        | 3     | Sessional examination |
| 2B      | Congenital abnormalities                   |                                               | Anomalies and echo detection - Kawasaki Disease.                                                                                                                                                | 2     | Sessional examination |

|    |                                 |  |                                                                                                                                                                                                                                                                               |   |                       |
|----|---------------------------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
| 2C | Echo in IHD                     |  | Detection of Ischemia -Role in acute coronary syndrome -Role in ischemic cardiomyopathy                                                                                                                                                                                       | 3 | Sessional examination |
| 2D | Chronic coronary artery disease |  | LV aneurysm -Pseudo aneurysm, Chronic remodeling, Mural thrombus -MR –Ischemic cardiomyopathy                                                                                                                                                                                 | 2 |                       |
| 2E | Echo in CCU                     |  | Management of acute MI<br>– Pathophysiology and Echocardiographic correlation<br><br>- Detecting an assessing MI,- correlation with coronary anatomy,<br><br>-Prognostication following MI,- Complications of MI                                                              | 3 | Sessional examination |
| 2F | Stress echocardiography         |  | Fundamentals, Types of Stress Echo-Interpretation of stress Echo-Technical aspects of non exercise test -Protocol, reversible ischemia detection, inducible ischemia/-viability and sensitivity and specificity -Assessment of disease significance and prognostic evaluation | 3 | Sessional examination |
| 2G | Echocardiography                |  | Approach and clinical                                                                                                                                                                                                                                                         | 2 | Sessional             |

|     |                                                |               |                                                                                                                                                                                                                                                                                                                                   |   |                       |
|-----|------------------------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
|     | evaluation of coronary blood flow              |               | applications-Doppler evaluation of coronary flow -Technical aspects and detection-assessment and clinical application                                                                                                                                                                                                             |   | examination           |
| 2H  | Newer techniques and their application for IHD |               | TDI, Strain, Strain rate, vector imaging,<br>-Myocardial contrast Echo                                                                                                                                                                                                                                                            | 2 | Sessional examination |
| 2 I | Surgical aspects of IHD                        |               | Role of Echo cardiographer- pre and post operative evaluation for CABG, Ischemic MR-repair vs replacement -Coronary anomalies echo aspects Dorr's procedure                                                                                                                                                                       | 2 | Sessional examination |
| 3   | Valvular Heart Disease                         | Valve anatomy | Mitral valve anatomy, -Mitral valve anatomy in surgeons view- Scallops of mitral valve in different echo views - Aortic valve anatomy<br><br>-Tricuspid valve anatomy -Pulmonary valve anatomy                                                                                                                                    | 5 | Sessional examination |
| 3A  | Echo in RF                                     |               | Acute vs chronic RF and valvular involvement                                                                                                                                                                                                                                                                                      | 2 | Sessional examination |
| 3B  | Mitral valve disease                           |               | MVP, -Mitral regurgitation-etiology Mechanism, Severity assessment - Sequential Evaluation. Chronic asymptomatic MR-Indication and Timing of Intervention for chronic valvular regurgitation-Assessment of Mitral stenosis<br><br>-Etiology<br><br>- Severity assessment, Indication and Valve assessment for Mitral Intervention | 6 | Sessional examination |

|    |                 |  |                                                                                                                                                                                                                                                                                                                                                                                              |   |                          |
|----|-----------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--------------------------|
| 3C | Aortic valve    |  | <p>Aortic regurgitation -Etiology-<br/>Quantification of</p> <p>AR –severity - Timing of surgery -<br/>Aortic stenosis -Etiology, Valvular,<br/>subvalvular and supra valvular<br/>stenosis. -Severity assessment, Use of<br/>stress Echo and strain in evaluation of<br/>AS , Low gradient severe AS with<br/>depressed and</p> <p>preserved EF, Myocardial response to<br/>chronic AS.</p> | 4 | Sessional<br>examination |
| 3D | Tricuspid valve |  | <p>TR-etiology,      Severity assessment,<br/>TS–etiology      and severity<br/><br/>assessment</p>                                                                                                                                                                                                                                                                                          | 2 |                          |
| 3E | Pulmonary valve |  | <p>Pulmonary      stenosis- valvular,<br/>supra valvular,<br/><br/>Infundibular,      Peripheral<br/>stenosis</p>                                                                                                                                                                                                                                                                            | 4 |                          |

|    |                        |  |                                                                                                                                                                                                                                                              |   |  |
|----|------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--|
|    |                        |  | Pulmonary regurgitation - Etiology and severity assessment, Ross procedure                                                                                                                                                                                   |   |  |
| 3F | Pulmonary hypertension |  | Etiology, PA pressure assessment by various methods                                                                                                                                                                                                          | 2 |  |
| 3G | Infective Endocarditis |  | Modified Dukes criteria Organisms, culture, Involvement of Valves, Indication for Echo, Prognostic stratification                                                                                                                                            | 3 |  |
| 3H | Prosthetic valves      |  | Types of prosthetic valves, Echo assessment in various valves, Prosthetic valve dysfunction, Prosthetic valve IE, Pannus formation and dehiscence,<br><br>Fluid dynamics of PV, Recognition and quantification of PV Dysfunction , 3DECHO and TEE evaluation |   |  |

#### Paper IV: Epidemiology & Biostatistics

Total hours: 60

| Sl. No. | Topics                                                                                                                                                                                                                                                             | 60 Hours |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1       | <b>Introduction</b><br><br>Introduction to Biostatistics & Research Methodology, types of variables & scales of measurements, measures of central tendency and dispersion, Skewness and Kurtosis Rate, Ratio, proportion, incidence, prevalence and their meaning. | 4        |
| 2       | <b>Sampling</b><br><br>Random & non random sampling, various methods of sampling-simple random, stratified, systematic, cluster and multistage. Sampling and non sampling errors.                                                                                  | 4        |

|   |                                                                                                                                                                                                                                                                                                                                                                                |    |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 3 | <b>Basic probability distribution and sampling distributions</b><br><br>Concept of probability distribution, normal, Poisson's and Binomial distributions, parameters and applications. Concept of sampling distributions. Standard error and confidence intervals.                                                                                                            | 6  |
| 4 | <b>Tests of Significance</b><br><br>Basics of testing of hypothesis – Null and alternate, hypothesis, type I and type II errors, level of significance and power of the test, p value. Tests of significance (parametric) T – test (paired & unpaired), Chi square test and test of proportion, one way analysis of variance. Repeated measures analysis of variance. Tests of | 10 |

|    |                                                                                                                                                                                                                                                                                 |    |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|    | significance (nonparametric) – Mann Whitney U Test, Wilcoxon Signed Rank Test, Kruskal – Wallis analysis of variance Friedmann’s analysis of variance.                                                                                                                          |    |
| 5  | <b>Correlation and Regression</b><br><br>Simple correlation – Pearson’s and Spearman’s methods ; testing the significance of correlation co-efficient simple and multiple linear regression.                                                                                    | 4  |
| 6  | <b>Sample size determination</b><br><br>General concept Sample size for estimating means and proportion, testing of difference in means, proportions of two groups and more than two groups.                                                                                    | 4  |
| 7  | <b>Study Designs</b><br><br>Descriptive epidemiological methods – case series analysis and prevalence studies. Analytical epidemiological methods – case control and cohort studies, Clinical trials / intervention studies, odds ratio and relative risk, stratified analysis. | 10 |
| 8  | <b>Multivariate analysis</b><br><br>Concept of multivariate analysis, introduction to logistic regression and survival analysis                                                                                                                                                 | 6  |
| 9  | <b>Reliability and validity evaluation of Diagnostic Tests</b><br><br>Cronbach’s alpha and Test- retest methods                                                                                                                                                                 | 4  |
| 10 | <b>Format of Scientific documents</b><br><br>Structure of Research protocol, structure of thesis/research report, formats of reporting in scientific journals. Systematic review and meta analysis.                                                                             | 8  |

## **Suggested Reading**

1. Surendar a Rao PSS and J Richard. Introduction Biostatistics and Research Methods, Prentice Hall of India (2006).
2. Abhaya Indrayan and Rajeev Kumar Malhotra, Medical Biostatistics, 4<sup>th</sup> Edition, CRC Press (2017)
3. Indrayan and Satyanarayana, Biostatistics for Medical, Nursing and pharmacy students, prentice Hall of India (2006)
4. Sarma K.V.S, Statistics made simple – do it yourself on PC, 2<sup>nd</sup> edition, Prentice Hall (2010)

## **Subsidiary Subject**

### **Ethics in Echocardiography: 10 HRS**

#### **(Should be taught to the 1st year students of M.Sc. Echocardiography)**

**Introduction:** With the advances in science and technology and the increasing needs of the patient, their families and community, there is a concern for the health of the community as a whole. There is a shift to greater accountability to the society. It is therefore absolutely necessary for each and every one involved in the health care delivery to prepare them to deal with these problems. Other professionals are confronted with many ethical problems.

Standards of professional conduct are necessary in the public interest to ensure an efficient laboratory service. Every sonologist or sonographer should not only be willingly to play his part in giving such a service, but should also avoid any act or omission which would prejudice the giving of the services or impair confidence, in respect, for sonologists or sonographer as a body.

To accomplish this and develop human values, it is desired that all the students undergo ethical sensitization by lectures or discussion on ethical issues.

#### **Introduction to ethics-**

What is ethics?

General introduction to Code of Laboratory Ethics

How to form a value system in one's personal and professional life? International code of ethics

#### **Professional Ethics-** Code of conduct Confidentiality

Fair trade practice Handling of prescription

Mal practice and Negligence Professional vigilance **Research Ethics-**

Animal and experimental research/ humanness Human experimentation Human volunteer research - informed consent Clinical trials

Gathering all scientific factors Gathering all value factors

Identifying areas of value – conflict, setting priorities, Working out criteria towards decision

ICMR/ CPCSEA/ INSA Guidelines for human / animal experimentation

### **Recommended reading**

Francis C.M., Medical Ethics, I Edition, 1993, Jay pee Brothers, New Delhi p189.

Good Clinical Practices: GOI Guidelines for clinical trials on Pharmaceutical Products in India ([www.cdsco.nic.in](http://www.cdsco.nic.in))

INSA Guidelines for care and use of Animals in Research – 2000.

CPCSEA Guidelines 2001([www.cpcsea.org](http://www.cpcsea.org)).

Ethical Guidelines for Biomedical Research on Human Subjects, 2000, ICMR, New Delhi. ICMR Guidelines on animal use 2001, ICMR, New Delhi.

## **PRACTICALS**

### **Paper –I: Embryology and ultrasound physics - 120 Hours**

#### **1. Echocardiographic demonstration: 5Hours**

Candidate will be allocated equipment for demonstration of procedure of maintenance,

Will be required to accompany service engineers and biomedical engineers during service visits and prepare at least six analyses of error and corrective actions taken.

Candidate will be required to perform rapid studies during OP peak hours under supervision and will participate in subsequent debriefing.

Will assist consultant in quality control exercise on a weekly basis.

#### **2. Basic Echocardiographic principles: 5 Hours**

Transducer selection

Reduction of artifacts

Obtaining optimal gray scale images

Gain and depth controls

Use of M-mode for temporal analysis of cardiac events and obtaining measurements

Use of modalities to optimize colour flow such as colour maps, gain and scale Adjustments related to Doppler such as scale, PRF, sweep, angle correction

Use of specialized techniques such as Tissue Doppler

#### **3. Echocardiographic examination (10 Hours)**

Will be required to perform calculations such as left ventricular mass and cardiac output, Calculation of cardiac mass,

Doppler equations, stroke distance, converting velocity to flow, flow to volumes, cardiac output, shunt ratios, modified Bernoulli equation and intra-vascular pressures, assessment of left ventricular, left atrial, right ventricular, right atrial pressures

Candidate would be required to store and retrieve studies of diagnostic quality-clinician satisfaction will be taken as a yardstick for performance

Applications of principles to obtaining, storing and retrieving optimal images.

**Clinical lab posting: 75 hours**

Students will be posted in the echocardiographic laboratory for the observation and to develop practice in the routine cardiac investigation by echocardiography.

**Hands on practical work: 25hours**

Students will be allowed to perform echocardiographic test independently under the supervision of the faculty to develop the skill and experience.

**Paper-II : Clinical cardiology 120 hours**

Clinical scenario given to the candidate for diagnosis and treatment of following disorders:

**150 Hr**

- |                              |                                            |
|------------------------------|--------------------------------------------|
| a. Unstable angina           | h. Atrial septal defect                    |
| b. Myocardial infarction     | i. Ventricular septal defect               |
| c. Left ventricular aneurysm | j. Tetralogy of Fallot                     |
| d. Congestive heart failure  | k. TGA (Transposition of Greater arteries) |
| e. Cardiac arrhythmia        | l. Ebstein's anomaly                       |
| f. Hypertension              | m. DORV (Double Outlet Right Ventricle)    |
| g. Hypotension               | n. Truncus Arteriosus                      |

**Cardiac Surgery**

Brief description of surgical steps involved in:

**5 Hours**

- a. Coronary artery bypass grafting (on pump CABG)
- b. Mitral valve replacement
- c. Aortic valve replacement
- d. ASD closure
- e. VSD closure
- f. Off-pump CABG

**Clinical lab posting: 75 hours**

Students will be posted in the echocardiographic lab, for the observation and to identify the correlation of clinical diagnosis with the echo findings with the help of clinical features, blood investigations, ECG, X-RAY etc.

Students will be recruited to the operation theater for the observation of the cardiac surgeries and to understand various techniques.

Students will be allowed to attend ward rounds along with the cardiologists.

Students will be demonstrated for ACLS and BLS, and posted clinically in ICCU for the observation and experience.

**Hands on practical work: 25hours**

Students will be allowed to read ECG and report X-RAY, perform echocardiographic test under the supervision of the faculty.

## Paper –III : Echocardiography for Ischemic valvular heart disease - 140 Hrs

### Ischemic and valvular heart disease, Echocardiography for ischemic heart disease

#### 20 Hours

1. **Understanding coronary circulation:** Coronary anatomy and physiology, pathogenesis of atherosclerotic plaques, abnormalities of coronary perfusion, wall thickening
2. **Wall motion scoring:** Regional left ventricular function, relationship to vascular supply, use of tissue Doppler where indicated, Segmental analysis for wall motion defects, coronary artery territories, detection and quantitation of Ischaemic muscle-wall motion scoring,
3. **Global ventricular function:** Linear measurements: indirect M-Mode markers of left ventricular function; Assessing global LV function; Evaluation of diastolic function: Methods for evaluating diastolic function, Doppler evaluation of diastolic function, Evaluation of mitral inflow, determination of isovolumetric relaxation time, Evaluation of pulmonary vein flow, Doppler tissue imaging, Assessment of overall performance of the Ischemic left ventricle-systolic and diastolic function, estimating volumes rule of disks.
4. **Myocardial infarction:** Detecting and assessing MI, correlation with coronary anatomy, prognostication following MI.
5. **Complications of MI:** Aneurysm, pseudo aneurysm, Ventricular Septal Defect, thrombo- embolic potential, right ventricular involvement.
6. **Stress echocardiography:** Protocols for stress echocardiography, detection of reversible Ischemic, detecting inducible ischemia/viability, specificity and sensitivity
7. **Newer techniques and their applications for IHD:** Tissue Doppler, strain, strain rate and velocity vector imaging, studying myocardial perfusion using contrast echocardiography.
8. **Surgical aspects of IHD-role of echo cardiographer:** Pre and postoperative evaluation for Coronary Artery Bypass Grafting (CABG), Linear endo-ventricular patchplasty (Dorr's procedure), Mitral regurgitation- morbid anatomy repair

versus replacement decision/post-operative, coronary anomalies-echocardiographic aspects.

#### 9. Recent developments in echocardiography for ischemic heart disease Textbooks and Reference Books:

1. Echocardiography by Feigenbaum (Eighth Edition)
2. Echo manuals by Mayo Clinic Lecture notes.
3. Journal articles
4. Cardiology by Braunwald (Twelfth edition) and Hurst (Sixteenth edition)

## **Echocardiography for valvular heart disease    20 Hrs.**

1. **Hemodynamic information derived from echocardiography:** Aortic flow, pulmonary flow, mitral flow, left atrial flow, tricuspid valve flow, cardiac output, regurgitant fraction shunt ratios, echocardiographic detection of stagnant blood flow, modified Bernoulli equation and intravascular pressures, echocardiographic findings with elevated left ventricular diastolic pressure, elevated left atrial pressures, pulmonary hypertension, right ventricular pressure, right atrial pressure.
2. **Mitral stenosis:** Etiopathogenesis, pathophysiology and hemodynamics, two-dimensional echocardiography in rheumatic mitral stenosis, congenital mitral stenosis, M-model echocardiographic appearance, transoesophageal echocardiography, three dimensional echo assessment for severity, anatomic determination of severity, exercise gradients, secondary features of mitral stenosis, Atrial fibrillation, secondary pulmonary hypertension, decision making regarding intervention; assessment for balloon mitral valvotomy-transesophageal echocardiography and its uses, post-procedural assessment, open mitral valvotomy versus mitral valve replacement- pre and post-operative assessment.
3. **Mitral regurgitation:** Doppler evaluation of mitral regurgitation, determination of mitral regurgitation, severity, Mitral valve prolapse and analysis of segments, Haemodynamics of MR, diagnosis of MR, assessing severity and secondary effects, pre-op, intra-op and post-operative, assessment for mitral valve repair, use of three dimensional echocardiography for mitral valve surgery, flail mitral valve, papillary muscle dysfunction. mitral annular calcium
4. **Tricuspid valve disease:** Anatomy and physiology of the healthy valve structural and functional changes in various disease states organic and functional involvement, tricuspid stenosis, tricuspid regurgitation and assessment of severity, approach to pulmonary artery hypertension.
5. **Aortic stenosis:** Etiopathogenesis and haemodynamics, sub-valvular, valvular and supra-valvular lesions, cuspal morphology, diagnosis and assessment of secondary effects, time course and prognostication, pre-operative and post-operative assessment; Diagnosis, assessing mechanism and severity, assessing site, possible etiology, secondary effects such as LV function, impact on associated lesions and therapeutic approach
6. **Aortic regurgitation:** Etiopathogenesis and haemodynamics, secondary effects, establishing a diagnosis, evaluating the severity of aortic regurgitation, acute versus chronic aortic regurgitation, relevant aspects of left ventricular function, timing of surgery, pre-operative and post-operative assessment.
7. **Pulmonary valve disease:** Embryology, morphology, infundibular, valvular, supra valvular and peripheral pulmonic stenosis, evaluation of the right ventricular outflow tract, miscellaneous abnormalities of the pulmonary valve assessing severity of pulmonic stenosis, pre and post procedural assessment for pulmonary valvuloplasty, pulmonary regurgitation.
8. **Prosthetic valves:** Types and normal function of mechanical valves, stenosis regurgitation, use of transesophageal echo for prosthetic valves, endocarditis: and its sequelae in native and prosthetic heart valves.

9. **Recent developments in echocardiography for valvular heart disease** Candidate would be allocated one or two patients/cases who are diagnosed with above (ischemic or valvular lesions) conditions, once in a week. They will be allowed to formulate the diagnostic question independently. The candidate will be analyzed by the faculty for the performance on the basis of diagnostic skill with the interpretation of the disease and looked for the knowledge on treatment modality. This will be followed by the brief discussion

**Textbooks and Reference Books:**

1. Echocardiography by Feigenbaum (Eighth Edition)
2. Echo manuals by Mayo Clinic Lecture notes.
3. Journal articles Cardiology by Braunwald (Twelfth edition) and Hurst (Sixteenth edition)

**Clinical lab posting: 75 hours**

Students will be posted in the echocardiographic laboratory for the observation and to develop practice in the cardiac investigation in ischemic and valvular heart disease by echocardiography.

**Hands on practical work: 25hours**

Students will be allowed to perform echocardiographic test independently under the supervision of the faculty to develop the skill and experience.



## **Second Year – Theory**

### **Paper V: Paediatric Echocardiography**

**Total hours: 46Hrs**

| <b>Unit No</b> | <b>Unit title</b>                          | <b>Unit objectives</b> | <b>Content</b>                                                                                                   | <b>Hours</b> | <b>Method of evaluation</b> |
|----------------|--------------------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------|
| 1              | Orientation and introduction to the course |                        |                                                                                                                  | 1            | Sessional examination       |
| 2              | Fetal cardiac Imaging                      |                        | Indications for fetal cardiac evaluation<br><br>Fetal physiology-Indications for fetal echocardiography          | 2            | Sessional examination       |
| 3              | Echo examination                           |                        | A segmental approach to anatomy-Cardiac situs<br><br>- Ventricular morphology<br><br>-Great arterial connections | 2            | Sessional examination       |
| 4              | Abnormalities of RV inflow                 |                        | Tricuspid stenosis and Regurgitation, Tricuspid atresia                                                          | 1            | Sessional examination       |
| 5              | Abnormalities of LV inflow                 |                        | -Pulmonary veins<br><br>- Left atrium-Mitral valve                                                               | 2            | Sessional examination       |
| 6              | Abnormalities of RV outflow                |                        | -Right ventricle-Pulmonary Valve-Pulmonary artery                                                                | 2            |                             |
| 7              | Abnormalities of LV outflow                |                        | -Subvalvular Obstruction - Valvular aortic stenosis<br><br>-Supravalvular aortic stenosis                        | 2            | Sessional examination       |
| 8              | Coarctation of aorta                       |                        | Types, Evaluation and Treatment                                                                                  | 2            | Sessional examination       |

|    |                                              |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                |    |                       |
|----|----------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----------------------|
| 9  | Abnormalities of cardiac septation           |  | Atrial septal defect-<br>-Ventricular septal Defect<br>-Endocardial cushion defect                                                                                                                                                                                                                                                                                                                                                             | 3  | Sessional examination |
| 10 | Abnormal vascular connections and structures |  | Patent ductus arteriosus-<br>Abnormal systemic venous connection<br><br>Abnormal pulmonary venous connection<br><br>-Abnormalities of the coronary circulation                                                                                                                                                                                                                                                                                 | 2  | Sessional examination |
| 11 | Cono truncal abnormalities                   |  | -Tetralogy of Fallot -Trans position of the great arteries,- Double outlet Right ventricle- Persistent truncus arteriosus- Aorto pulmonary window                                                                                                                                                                                                                                                                                              | 3  | Sessional examination |
| 12 | Abnormalities of ventricular development     |  | Hypoplastic left heart syndrome - single ventricle- Tricuspid atresia                                                                                                                                                                                                                                                                                                                                                                          | 3  | Sessional examination |
| 13 | M-mode and 2D in CHD                         |  | Basics of imaging and sequential segmental analysis - Left to right shunts<br><br>-Atrio ventricular septal defect<br>Congenital left ventricular and right ventricular inflow anomalies<br><br>-Left ventricular outflow tract obstruction.<br><br>Echocardiographic anatomy of TOF with PS-Complete transposition of great arteries<br><br>- AV/VA discordance<br><br>- Pulmonary veins-Imaging of coronary anomalies and pulmonary arteries | 10 | Sessional examination |

|    |                                                                                      |  |                                                                                                                                                    |   |                       |
|----|--------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
|    |                                                                                      |  | - Echocardiographic evaluation of aortic arch and its anomalies- Univentricular heart and heterotaxy syndrome.                                     |   |                       |
| 14 | 3D echo in CHD For quantification of ventricular volumes, Mass and function with CHD |  | LV volume, EF and Mass-RV volume, EF and Mass -Single ventricular volumes, EF and mass - 3D analysis of regional wall motion, Synchrony and strain | 3 | Sessional examination |
| 15 | Echo in the evaluation of adults with CHD                                            |  | Simple congenital heart defects in adults<br><br>Valvular heart disease Complex congenital heart                                                   | 2 |                       |

|    |                                                        |  |                                                                                                                                                                             |   |                       |
|----|--------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
|    |                                                        |  | defects                                                                                                                                                                     |   |                       |
| 16 | Echo evaluation during and after surgery               |  | Systemic artery to pulmonary artery shunts<br><br>Pulmonary artery bands<br><br>Fontan procedure<br><br>-Right ventricle to pulmonary artery conduits                       | 3 | Sessional examination |
| 17 | Echo evaluation of acquired heart disease in childhood |  | IE-Modified DukeCriteria for the diagnosis of IE<br><br>Echo findings in Complications of IE . RHD-Johns criteria.<br><br>Kawasaki disease - Coronary ectasia and aneurysms | 3 | Sessional examination |

**Paper VI: Echocardiography in Myocardial, Pericardial, Aortic and Systemic Disorders & Non-Cardiac Diagnosis**

**Total hours: 47**

| Unit No     | Unit title                                                  | Unit objectives | Content                                                                                                                        | Hours | Method of evaluation  |
|-------------|-------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------|
| 1           | Orientation and introduction to the course                  |                 |                                                                                                                                | 1     | Sessional examination |
| 2<br><br>2A | Echo in cardiomyopathies<br><br>Hypertrophic cardiomyopathy |                 | Definition and types of hypertrophy -Mid LV hypertrophic cardiomyopathy<br><br>-Differential Diagnosis<br>Treatment strategies | 12    | Sessional examination |

|    |                                                |  |                                                                                                                                                |  |  |
|----|------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| 2B | Dilated cardiomyopathy                         |  | Secondary findings in DCM -<br>Etiology of<br><br>DCM-Doppler evaluation of<br>systolic and diastolic<br><br>function -Therapeutic<br>decision |  |  |
| 2C | Infiltrative and Restrictive<br>cardiomyopathy |  | Echo evaluation of<br><br>RCM -Constrictive versus<br>restrictive heart disease                                                                |  |  |
| 2D | Peripartum<br>cardiomyopathy                   |  |                                                                                                                                                |  |  |
| 2E | Non-compaction LV/RV<br>cardiomyopathy         |  |                                                                                                                                                |  |  |
| 2F | Endocardial fibro                              |  |                                                                                                                                                |  |  |

|   |                                                                               |  |                                                                                                                                                                                                                                                                                            |    |                       |
|---|-------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----------------------|
|   | elastosis and hyper eosinophilic syndrome                                     |  |                                                                                                                                                                                                                                                                                            |    |                       |
| 3 | Echocardiographic Differentiation of ischemic and non ischemic cardiomyopathy |  | <p>Echocardiographic assessment of ischemic and non ischemic cardiomyopathy</p> <p>-M-mode echocardiography</p> <p>-2D/3D /Doppler echocardiography</p> <p>- Distinction between ischemic and non ischemic dilated cardiomyopathy-</p> <p>Other</p> <p>non invasive imaging modalities</p> | 10 | Sessional Examination |
| 4 | Pericardial disease                                                           |  | <p>Acute pericarditis -</p> <p>Pericardial effusion , M-Mode and 2D echocardiography-Cardiac tamponade -Constrictive Pericarditis –Congenital anomalies-3D echo assessment in pericardial disease -2D versus 3D echocardiography</p>                                                       | 5  | Sessional examination |
| 5 | Diseases of the Aorta                                                         |  | <p>Echocardiographic Evaluation</p> <p>-Aortic dilatation and Aneurysm - Marfan' syndrome - Sinus of valsalva aneurysm - Aortic dissection - Aortic pseudo aneurysm, Aortic Trauma-Infections of the aorta- Aortic prosthesis thrombus -Takayasu arteritis</p>                             | 5  | Sessional examination |

|   |                                    |  |                                                                                                                             |   |                          |
|---|------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------|---|--------------------------|
| 6 | Echo in systemic disease           |  | Hypertension -DM-<br>Connective tissue /auto<br>immune disease-Chronic liver<br>disease-COPD<br><br>-Pulmonary hypertension | 5 | Sessional<br>examination |
| 7 | Echocardiography in the<br>Elderly |  | Aortic atherosclerosis and<br>penetrating aortic Ulcer -<br>Aortic valve Sclerosis - Aortic<br>stenosis -Aortic             | 5 | Sessional<br>examination |

|   |                                                                 |  |                                                                                                                                                                             |   |                          |
|---|-----------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--------------------------|
|   |                                                                 |  | aneurysm- Aortic<br>Dissection -LV Masses,<br>Dimensions and function-<br>Echocardiography<br>in stroke patients -<br>Mitral<br>annular calcification-<br>Prosthetic valves |   |                          |
| 8 | Echocardiographic<br>assessment of Cardiac<br>Tumors and Masses |  | Echocardiographic<br>assessment of cardiac tumors<br>and masses<br><br>- Primary Benign<br>cardiac tumors<br><br>-Malignant<br>primary cardiac tumors                       | 4 | Sessional<br>examination |

#### Paper VII: Recent advances

Total hours: 47

| Unit<br>No | Unit title                                                  | Unit<br>objectives | Content                                                                                                                                                                   | Hours | Method of<br>evaluation  |
|------------|-------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------|
| 1          | Orientation and<br>introduction to the<br>course            |                    |                                                                                                                                                                           | 1     | Sessional<br>examination |
| 2          | Monitoring ventricular<br>function in<br>the operating room |                    | LV filling -Global systolic Function,<br>Regional wall motion abnormality-<br>Use of TEE in operating room to<br>monitor cardiac function in<br>specific cardiac entities | 2     | Sessional<br>examination |

|   |                                                               |  |                                                                                                                                                                                                                                                                                                            |   |                       |
|---|---------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
| 3 | Contrast ultrasound imaging, Method, Analysis and Application |  | Characteristics of microbubbles<br>Ultrasonographic contrast agent,<br>Ultrasonographic imaging technique-Method of analysis-<br>Clinical applications of ultrasonographic contrast-<br>Myocardial contrast echocardiography, Indications for use of ultrasound contrast-<br>Safety of ultrasound contrast | 3 | Sessional examination |
| 4 | Myocardial perfusion echocardiography                         |  | Acute coronary syndromes<br>Assessment of myocardial viability<br><br>Chronic coronary artery disease                                                                                                                                                                                                      | 2 | Sessional examination |
| 5 | Endothelial Dysfunction                                       |  | Endothelial function and Dysfunction -Role of Acetylcholine<br>-Shear stress and                                                                                                                                                                                                                           | 3 | Sessional examination |

|    |                                                           |  |                                                                                                                                                                                                                                                                                         |   |                       |
|----|-----------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
|    |                                                           |  | <p>flow mediated Dilatation-NO Release-Methodology for Assessing endothelial function-Analysis of shear stress and flow mediated dilatation response-Factors affecting the flow mediated dilatation- Limitations - Other non invasive methods to assess</p> <p>endothelial function</p> |   |                       |
| 6  | 3D- Transthorasic and TEE echo examination and performing |  | <p>3D TEE Technology</p> <p>-Performing 3D TEE</p> <p>-Evaluation -Specific uses of 3D TEE</p>                                                                                                                                                                                          | 2 | Sessional examination |
| 6A | 3D TEE to evaluate valvular heart disease.                |  | 3D echo image optimization- 3D echo of the mitral valve - 3D echo of the aortic valve-3D echo of the pulmonic valve - 3D echo of the Tricuspid valve                                                                                                                                    | 2 |                       |
| 6B | 3D TEE in operating room                                  |  | <p>Mitral Valve disease-Aortic valve disease-Tricuspid valve disease-Native valve endocarditis-Prosthetic valve</p> <p>dysfunction-Cardiac masses</p>                                                                                                                                   | 2 |                       |
| 6C | 3D guidance of Percutaneous procedures                    |  | <p>Fluoroscopy versus echocardiography in guiding percutaneous interventions-Trans-septal puncture, Device closure of cardiac shunts-Occlusion of the LA appendage-Guidance for electrophysiology procedures, Miscellaneous procedures</p>                                              | 4 |                       |

|   |                                                        |  |                                                                                                                                                                                                                                               |   |                       |
|---|--------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
| 7 | Speckle tracking echocardiography; clinical usefulness |  | Cardiac muscular anatomy- what is strain-2D speckle tracking echocardiography<br><br>-Image acquisition and processing<br>- Clinical application of 2D STE-3D speckle tracking echocardiography - Clinical applications of 3D STE- Limitation | 3 | Sessional examination |
| 8 | Intra cardiac echocardiography                         |  | Equipment and the Catheters- Imaging specification-clinical                                                                                                                                                                                   | 2 | Sessional examination |

|    |                                                                     |  |                                                                                                                                                                                                                                                                                    |   |                       |
|----|---------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
|    |                                                                     |  | applications-intra cardiac echocardiography during EP intervention -During structural intervention                                                                                                                                                                                 |   |                       |
| 9  | Intravascular ultrasound imaging                                    |  | Principles of Ultrasound - Technology-Image acquisition- Intravascular ultrasound examination<br><br>Image interpretation -Utility of intravascular ultrasound in clinical practice                                                                                                | 3 | Sessional examination |
| 10 | Peripheral vascular ultrasound                                      |  | Ultrasound diagnosis of carotid artery diseases Ultrasound diagnosis of Femoral access complications                                                                                                                                                                               | 2 | Sessional examination |
| 11 | Advanced Non invasive Quantification Techniques in echocardiography |  | Clinical applications of advanced 3D echo quantification tools -RV quantification -Mitral valve assessment -Aortic valve assessment -Conclusion                                                                                                                                    | 3 | Sessional examination |
| 12 | Echocardiography in Women                                           |  | Structural heart disease:-MVP, Mitral stenosis, Mitral annular calcification -Ischemic heart disease -Stress echocardiography - Polycystic ovarian Syndrome - Takotsubo cardiomyopathy-CHD<br><br>-Echocardiography in pregnancy- Peripartum cardiomyopathy-Fetal echocardiography | 2 | Sessional examination |
| 13 | Echo for the Electrophysiologist                                    |  | Echocardiography in SVT-Left atrium<br><br>Atrial septum-Pulmonary veins- Inferior venacava- Echocardiography in VT-Echocardiography in cardiac Implantable                                                                                                                        | 3 | Sessional examination |

|  |  |  |                    |  |  |
|--|--|--|--------------------|--|--|
|  |  |  | electronic devices |  |  |
|--|--|--|--------------------|--|--|

|    |                                                    |  |                                                                                                                                                                                                                                                                        |   |                       |
|----|----------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
| 14 | Echo in life threatening conditions                |  | <p>Chest trauma-Penetrating chest trauma-Acute Mitral regurgitation</p> <p>Acute severe AR -Aortic dissection-Debakey classification - The Stanford classification</p> <p>Pulmonary thromboembolic Disease -Air embolism Hypovolemia - Large intracardiac thrombus</p> | 4 |                       |
| 15 | A Primer on cardiac MRI for the Echo cardiographer |  | <p>Quantitative left and right ventricular</p> <p>assessment -Strain assessment LV structure -Myocarditis and Sarcoidosis-cardiac hypertrophy,Cardiomyopathies</p> <p>-Velocity Mapping, Flow and shunt Assessment -Valvular heart disease and prosthetic valves</p>   | 3 | Sessional examination |
| 16 | Fetal echocardiography                             |  | <p>Echocardiography in diagnosis of heart disease in pregnancy- Indication-Extra cardiac reasons and associations for fetal heart disease - Fundamentals of fetal cardiac imaging</p>                                                                                  | 2 | Sessional examination |

## **PRACTICALS**

### **Paper - V: Paediatric Echocardiography 140 HRS**

#### **40 Hours**

1. Paediatric echocardiography: Segmental approach, Assessing visceral and cardiac situs, veno-atrial connection, atrio-ventricular and ventriculo-great artery relation, Ventricular loop, Great artery position, Aortic arch visualization.
2. Abnormalities of right ventricular inflow
3. Abnormalities of left ventricular inflow: Pulmonary veins, left atrium, and mitral valve.
4. Abnormalities of right ventricular outflow: Right ventricle, pulmonary valve, pulmonary artery
5. Abnormalities of left ventricular outflow: sub-valvular obstruction, Valvular aortic stenosis, supra-valvular aortic stenosis.
6. Coarctation of the aorta
7. Abnormalities of cardiac septation: Atrial septal defect, ventricular septal defect, endocardial cushion defect.
8. Abnormalities vascular connection and structures: patent ductus arteriosus, abnormal systemic venous connections, abnormal pulmonary venous connections, abnormalities of the coronary circulation.
9. Cono-truncal abnormalities: Tetralogy of Fallot, transposition of the great arteries, double outlet right ventricle, persistent truncus arteriosus and aortopulmonary window.

Candidate would be allocated one or two patients/cases who are diagnosed with above conditions, once in a week. They will be allowed to formulate the diagnostic questions independently. The candidate will be analyzed by the faculty for the performance on the basis of diagnostic skill with the interpretation of the disease and looked for the knowledge on treatment modality. This will be followed by the brief discussion.

#### **Clinical lab posting: 75 hours**

Students will be posted in the echocardiographic laboratory for the observation and to develop practice in the cardiac investigation of congenital heart disease by echocardiography.

#### **Hands on practical work: 25hour**

Students will be allowed to perform echocardiographic test independently under the supervision of the faculty to develop the skill and experience.

## Paper - VI: Echocardiography in Myocardial, Pericardial, Aortic

and Systemic Disorders & Non-Cardiac Diagnosis -125Hrs

25 Hours

1. **Hypertrophic Cardiomyopathy:** Morphological variants, diagnosis, haemodynamics, echocardiography evaluation of hypertrophic cardiomyopathy, assessing intracavitary and outflow tract gradients in obstructive cardiomyopathy, Mitral regurgitation in hypertrophic cardiomyopathy, other variants of hypertrophic cardiomyopathy, mid-cavity obstruction, conditions mimicking hypertrophic cardiomyopathy, therapeutic decision making and monitoring in hypertrophic cardiomyopathy, evaluation of therapy, pre and post-procedural evaluation.
2. **Idiopathic dilated cardiomyopathy:** Diagnosis and differentiation from other disorders such as IHD, Doppler evaluation of systolic and diastolic function, secondary findings in dilated cardiomyopathy, etiology of dilated cardiomyopathy, determination of prognosis in dilated cardiomyopathy, pre and post-procedural evaluation for cardiac re- synchronization therapy. Overview of cardiac transplantation.
3. **Restrictive Cardiomyopathy:** Diagnosis and haemodynamics, infiltrative cardiomyopathies, miscellaneous- myocardial diseases in neuromuscular disorders, infectious agents and toxins.
4. **Diseases of the pericardium:** Pericardial effusion: Detection of fluid, diagnosis-pleural versus pericardial fluid, quantitation, loculated effusions, cardiac tamponade-diagnosis, haemodynamics etiology, pericardiocentesis, Constrictive pericarditis: Diagnosis and haemodynamics. Differentiation from restrictive Cardiomyopathy, pre and post-surgical evaluation. Miscellaneous: acute pericarditis, pericardial thickening, pericardial cysts, absent pericardium.
5. **Diseases of the aorta:** Aortic dilatation and aneurysms, Aortic dissection-diagnosis and classification, false aneurysms, aneurysms of the aortic sinuses-rupture, haemodynamics, pre-and postsurgical evaluation. Miscellaneous- trauma, infections, aorta-left-ventricular tunnel, atherosclerosis, echocardiographic evaluation, aortic dilation and aneurysm, marfan syndrome, Sinus of valsalva aneurysm, aortic atheroma. Role of trans-esophageal echocardiography.
6. **Echocardiography in systemic disorders:** Diabetes hypertension, renal failure, neurological conditions, collagen vascular diseases and so on.
7. **Cardiac masses:** Tumors and source of embolus: Normal variants and artifacts, cardiac tumors; primary tumors, metastatic tumors of the heart, secondary effects, Masses, extra cardiac masses, intra cardiac thrombi, ultrasonic typing, man-made objects in the heart; Intra-cardiac thrombi: left ventricular thrombi, left atrial thrombi, right atrial thrombi, spontaneous echo contrast.
8. **Echo findings with altered electrical activation:** Normal and abnormal depolarization and conduction of the cardiac impulse, bundle branch blocks and Wolf-Parkinson-White syndrome, ectopic rhythm-ventricular and supra-ventricular, pacemakers.

**9. Recent developments in echocardiography in myocardial, pericardial, aortic and systemic disorders**

**10. Infective endocarditis.**

Candidate would be allocated one or two patients/cases who are diagnosed with above conditions, once in a two week. They will be allowed to formulate the diagnostic question independently. The candidate will be analyzed by the faculty for the performance on the basis of diagnostic skill with the interpretation of the disease and looked for the knowledge on treatment modality. This will be followed by the brief discussion.

**Textbooks and Reference Books:**

1. Echocardiography by Feigenbaum (Eighth Edition)
2. Echo manuals by Mayo Clinic Lecture notes.
3. Journal articles Cardiology by Braunwald (Twelfth Edition) and Hurst (Sixteenth edition)

### **Clinical lab posting: 75 hours**

Students will be posted in the echocardiographic laboratory for the observation and to develop practice in the echocardiographic examination in myocardial, pericardial, aortic and systemic disorders.

### **Hands on practical work: 25hours**

Students will be allowed to perform echocardiographic test independently under the supervision of the faculty to develop the skill and experience.

### **Paper- VII- Recent advances 125Hrs**

#### **25 Hours**

#### **1. Tissue Doppler(TDI) and Deformation Imaging**

Technical Principles of Tissue velocity, strain and strain rate imaging Introduction

Tissue velocity imaging

Pulsed wave tissue velocity imaging Color tissue velocity imaging Curved anatomical M-mode Concepts of strain and strain rate Definition of strain and Strain rate

Estimation of strain and strain rate from ultrasound data Artifacts and methods to improve signal quality

#### **2. Principles and different technique for speckle tracking**

Introduction

Principles of speckle tracking Strain and strain rate assessment Torsion and twist

#### **3. Application of echocardiography in hemodynamic evaluation**

Assessment of filling pressure at rest Heart failure and LV filling pressure

Role of standard Echocardiography in Assessment of LV filling pressure Mitral inflow,

Pulmonary venous flow

Colour M-mode flow propagation velocity

Role of TDI in Assessment of LV filling pressure

Doppler estimation of LV filling pressure in AF

#### **4. Assessment of LV filling pressure with strain**

#### **5. Assessment of Systolic Heart failure**

Introduction

Regional systolic and long axis function Assessment of LV filling pressure

Tissue Doppler imaging in heart failure with MR Tricuspid annular Velocities and RV function

## **6. Assessment of Diastolic Heart failure**

Introduction, Grading of dysfunction

Differential diagnosis in a patient with Heart failure and Ejection fraction Echocardiography as a tool for Assessment of heart failure

## **7. Assessment of cardiac dyssynchrony and its application**

Introduction

Methods of Assessment of cardiac dyssynchrony by myocardial imaging RV pacing -induced systolic dyssynchrony

Role of cardiac dyssynchrony, Assessment in cardiac resynchronization therapy: Tissue Doppler imaging

## **8. Ischemic heart disease**

Experimental study on myocardial ischemia and viability using tissue Doppler and deformation

## **9. Use of tissue velocity imaging during stress echocardiography**

## **10. Tissue Doppler echocardiography in the assessment of Hypertensive heart disease**

## **11. Constrictive Pericarditis versus Restrictive cardiomyopathy**

## **12. Use of Myocardial imaging to identify and manage sub clinical heart disease in thyroid and other endocrine heart disease**

## **13. Myocardial imaging in valvular heart disease** Myocardial imaging in mitral valve disease Myocardial imaging in Aortic valve disease

## **14. Tissue Doppler Imaging and strain rate imaging to evaluate RV function.**

## **15. 3 D Echocardiography Principles & Clinical Application**

## **16. Automated Functional Imaging**

## **17. 3D TEE**

Clinical Applications & Instrumentation

## **18. Cardiac resynchronization therapy**

## **19. Contrast Echocardiography**

## **20. Fetal Echocardiography.**

Candidates will be trained by the faculty in the echocardiographic lab to obtain technical skill on recent indices of Tissue Doppler imaging including strain and strain rate measurement. Periodically one or two hours per month, candidates will be subjected to random cases for which, the assessment will be carried out by applying all the Deformation techniques under the supervision of the faculty and then the appropriate discussion is recruited to reduce the means of error in the analysis.

### **Clinical lab posting: 75 hours**

Students will be posted in the echocardiographic laboratory for the observation and to develop practice in the echocardiographic examination for diagnosing subtle changes in the myocardium in systemic, valvular, congenital heart diseases. Observing the echo guided CRT analysis to understand the prognostication and to identify the responders.

### **Hands on practical work: 25hours**

Students will be allowed to perform echocardiographic test independently under the supervision of the faculty to develop the skill and experience

### **Section-III**

#### **Minimum requirement of infrastructure, laboratory facilities and staff:**

##### **(i) Basic Infrastructure:**

Institute should have its own hospital with full-fledged cardiology unit with the following facilities:

- 25 bedded cardiology / cardiac surgery services
- Echocardiography laboratory with 4 echocardiography machines
- Class room with capacity for 30 students, measuring 500 sq.ft
- One departmental Seminar room measuring 250sq.ft for each branch with A.V

aids – OHP, Slide projector and computer with accessories are compulsory. LCD Projector (optional) other infrastructure criteria- Principals room, students common room, staff room, Library, office room, Store room, preparation room etc will be as per minimum criteria. Norms of B.Sc-Cardio vascular/Cardiac Care Technology course.

##### **(ii). Infrastructure subject wise**

- Anatomy laboratory
- Physiology laboratory
- Echocardiography equipments
  - i. Echocardiography machines – 4
  - ii. Transoesophageal echocardiography probes –01
  - iii. OPD case load for echocardiography – 50 / day
  - iv. Cardiology OPD attendance – 100 / day
  - v. Cardiology inpatient service minimum – 50 beds
  - vi. Cardiac surgical case load – 10 operations / day

**Suggested Readings:**

1. Feigenbaum Present / Eighth edition
2. 'Otto' Text book of Echo 6<sup>th</sup> edition
3. Echo manual – Joe
4. Indian Text book of Echocardiography: Amuthan . V
5. Jaypee publishers : Text book of Echo : Navin C Nanda
6. 3D Echo : Dr Amuthan . V
7. Valvular Heart Disease : Dalen & Alpert
8. 'Otto' : 3 D TEE Primer
9. Echocardiography review Guide "Otto"
10. Atlas of 3 D Echo: Edward A. Gill
11. 3 D Echo: Takakhiro Shiota

## SECTION- IV MONITORING LEARNING PROGRESS

It is essential to monitor the learning progress of each candidate through continuous appraisal and regular assessment. It not only also helps teachers to evaluate students, but also students to evaluate themselves. The monitoring must be done by the staff of the department based on participation of students in various teaching / learning activities. It may be structured and assessment be done using checklists that assess various aspects. Model Checklists are given in this Chapter, which may be copied and used.

The learning out comes to be assessed should include:

- i) **Acquisition of Knowledge:** The methods used comprise of 'Log Book' which records participation in various teaching / learning activities by the students. The number of activities attended and the number in which presentations are made are to be recorded. The logbook should periodically be validated by the supervisors. Some of the activities are listed. The list is not complete. Institutions may include additional activities, if so, desired.

**Journal Review Meeting (Journal Club):** The ability to do literature search, in depth study, presentation skills, and use of audio- visual aids are to be assessed. The assessment is made by faculty members and peers attending the meeting using a checklist

**Seminars / Symposia:** The topics should be assigned to the student well in advance to facilitate in depth study. The ability to do literature search, in depth study, presentation skills and use of audio- visual aids are to be assessed using a checklist

- ii) **Teaching skills:** Candidates should be encouraged to teach undergraduate medical students and paramedical students, if any. This performance should be based on assessment by the faculty members of the department and from feedback from the undergraduate students

- iii) **Dissertation:** Review of dissertation at frequent intervals with faculty, adherence to ethics

- iv) **Work diary / Log Book-** Every candidate shall maintain a work diary and record his/her participation in the training programmes conducted by the department such as journal,

reviews, seminars, etc. Special mention may be made of the presentations by the candidate as well as details of experiments or laboratory procedures, if any conducted by the candidate.

- v) **Records:** Records, log books and marks obtained in tests will be maintained by the Head of the Department and will be made available to the University.

**Log book:**

The logbook is a record of the important activities of the candidates during his training; Internal assessment should be based on the evaluation of the logbook. Collectively, logbooks are a tool for the evaluation of the training programme of the institution by external agencies. The record includes academic activities as well as the presentations and procedures carried out and assisted by the candidate.

**Format for the logbook** for the different activities is given in Tables 1 and 2 of Section IV. Copies may be made and used by the institutions.

**Checklist - I****Model Checklist for Evaluation of Journal Review Presentations**

Name of the student: \_\_\_\_\_ Date: \_\_\_\_\_

Name of the faculty/ Observer: \_\_\_\_\_

| Sl No. | Items for observation during presentation                                   | Poor | Below average | Average | Good | Very Good |
|--------|-----------------------------------------------------------------------------|------|---------------|---------|------|-----------|
|        |                                                                             | 0    | 1             | 2       | 3    | 4         |
| 1      | Article chosen was                                                          |      |               |         |      |           |
| 2      | Extent of understanding of scope & objectives of the paper by the candidate |      |               |         |      |           |
| 3      | Whether cross- references have been consulted                               |      |               |         |      |           |
| 4      | Whether other relevant references have been consulted                       |      |               |         |      |           |
| 5      | Ability to respond to questions on the paper /subject                       |      |               |         |      |           |
| 6      | Audio-visuals aids used                                                     |      |               |         |      |           |
| 7      | Ability to defend the paper                                                 |      |               |         |      |           |
| 8      | Clarity of presentation                                                     |      |               |         |      |           |
| 9      | Any other observation                                                       |      |               |         |      |           |
|        | <b>Total score</b>                                                          |      |               |         |      |           |

## Checklist - II

### Model Check List for the Evaluation of the Seminar Presentations

Name of the student: \_\_\_\_\_ Date: \_\_\_\_\_

Name of the faculty/ Observer: \_\_\_\_\_

| Sl No. | Items for observation during presentation                                   | Poor | Below average | Average | Good | Very Good |
|--------|-----------------------------------------------------------------------------|------|---------------|---------|------|-----------|
|        |                                                                             | 0    | 1             | 2       | 3    | 4         |
| 1      | Article chosen was                                                          |      |               |         |      |           |
| 2      | Extent of understanding of scope & objectives of the paper by the candidate |      |               |         |      |           |
| 3      | Whether cross- references have been consulted                               |      |               |         |      |           |
| 4      | Whether other relevant references have been consulted                       |      |               |         |      |           |
| 5      | Ability to respond to questions on the paper /subject                       |      |               |         |      |           |
| 6      | Audio-visuals aids used                                                     |      |               |         |      |           |
| 7      | Ability to defend the paper                                                 |      |               |         |      |           |
| 8      | Clarity of presentation                                                     |      |               |         |      |           |
| 9      | Any other observation                                                       |      |               |         |      |           |
|        | <b>Total score</b>                                                          |      |               |         |      |           |

### Checklist – III

#### Model Check list for Evaluation of Teaching Skill

Name of the student:\_\_\_\_\_Date:\_\_\_\_\_

Name of the faculty/ Observer:\_\_\_\_\_

| SL. No. |                                                       | Strong Point | Weak point |
|---------|-------------------------------------------------------|--------------|------------|
| 1       | Communication of the purpose of the talk              |              |            |
| 2       | Evokes audience interest in the subject               |              |            |
| 3       | The introduction                                      |              |            |
| 4       | The sequence of ideas                                 |              |            |
| 5       | The use of practical examples and /or illustrations   |              |            |
| 6       | Speaking style (enjoyable, monotonous, etc., specify) |              |            |
| 7       | Summary of the main points at the end                 |              |            |
| 8       | Ask questions                                         |              |            |
| 9       | Answer questions asked by the audience                |              |            |
| 10      | Rapport of speaker with his audience                  |              |            |
| 11      | Effectiveness of the talk                             |              |            |
| 12      | Uses of AV aids appropriately                         |              |            |

### Checklist - IV

#### Model Check list for Dissertation / Project Work Presentations

Name of the student: \_\_\_\_\_ Date: \_\_\_\_\_

Name of the faculty/ Observer: \_\_\_\_\_

| Sl No. | Points to be considered                 | Poor | Below average | Average | Good | Very Good |
|--------|-----------------------------------------|------|---------------|---------|------|-----------|
|        |                                         | 0    | 1             | 2       | 3    | 4         |
| 1      | Interest shown in selecting topic       |      |               |         |      |           |
| 2      | Appropriate review                      |      |               |         |      |           |
| 3      | Discussion with guide and other faculty |      |               |         |      |           |
| 4      | Quality of protocol                     |      |               |         |      |           |
| 5      | Preparation of proforma                 |      |               |         |      |           |
|        | <b>Total score</b>                      |      |               |         |      |           |

### Checklist – V

Continuous Evaluation of dissertation / project work ByGuide/  
Co-Guide

Name of the student: \_\_\_\_\_ Date: \_\_\_\_\_

Name of the faculty/ Observer: \_\_\_\_\_

| Sl No. | Items for observation during presentation  | Poor | Below average | Average | Good | Very Good |
|--------|--------------------------------------------|------|---------------|---------|------|-----------|
|        |                                            | 0    | 1             | 2       | 3    | 4         |
| 1      | Periodic consultation with guide/ co-guide |      |               |         |      |           |
| 2      | Depth of Analysis/ Discussion              |      |               |         |      |           |
| 3      | Department presentation of findings        |      |               |         |      |           |
| 4      | Quality of final output                    |      |               |         |      |           |
| 5      | Others                                     |      |               |         |      |           |



# MODEL QUESTION PAPER

## THEORY

Each theory paper will have

- 1) Essay questions – 03 nos. carrying 10 marks each - 03 x 10 = 30
- 2) Short answer questions – 10 nos. carrying 05 marks each - 10 x 05 = 50

Total = 80

Internal assessment = 20

## PRACTICAL

(a) Preliminary:

|                        |       |      |
|------------------------|-------|------|
| Internal assessment    | :     | 15   |
| University examination | :     | 60   |
|                        | Total | = 75 |
| (b) Viva               |       | = 25 |