KCG

COLLEGE OF TECHNOLOGY

B.E - Mechanical Engineering

(Anna University Regulation - 2013)

FIFTH SEMESTER

QUESTION BANK

DEPARTMENT OF MECHANICAL ENGINEERING

KCG COLLEGE OF TECHNOLOGY,

CHENNAI – 600097

VISION OF THE COLLEGE

KCG College of Technology aspires to become a globally recognized centre of excellence for science, technology & engineering education, committed to quality teaching, learning, and research while ensuring for every student a unique educational experience which will promote leadership, job creation, social commitment and service to nation building

MISSION OF THE COLLEGE

- Disseminate knowledge in a rigorous and intellectually stimulating environment
- Facilitate socially responsive research, innovation and entrepreneurship
- Foster holistic development and professional competency
- Nurture the virtue of service and an ethical value system in the young minds

VISION OF THE DEPARTMENT

The department aspires to become a globally recognized centre of excellence by producing competent professionals in Mechanical Engineering to serve as a valuable resource for industry and society

MISSION OF THE DEPARTMENT

- Impart intellectually rigorous and holistic education to the Students in the field of Mechanical Engineering.
- Establish state of-the-art facilities for research and consultancy work.
- Enhance the knowledge and skills of the faculty with the latest advancements in the mechanical engineering domain.
- Mentor the students to develop research and entrepreneurial capabilities.
- Inculcate a high degree of professionalism and contribute to the needs of industry and society

PROGRAMME EDUCATIONAL OBJECTIVES:

On completion of the program, the students will achieve the following:

PEO1: Graduates of the programme, will continuously update their domain knowledge for continuous professional development with focus on research & development and industry interaction.

PEO2: Graduates of the programme will create innovations in providing solution for sustainable built environment.

PEO3: Graduates will be familiar with modern engineering software tools and equipment to analyze complex civil engineering problems.

PEO4: Graduates of the programme will involve in the research world to meet the practical challenges.

PEO5: Graduates of the programme will be professional civil engineers with ethical and societal responsibility.

PROGRAMME OUTCOMES

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solution for complex engineering problems and design systems components or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environmental and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-Long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO 1 To specialize the students in the field of automotive design, manufacturing and fabrication methods, cost estimation and analysis

PSO 2 To equip the students with the knowledge of advanced metrology

PSO 3 To expose students in the field of Heat Ventilation & Air Conditioning

ME6501
COMPUTER AIDED DESIGN SYLLABUS
REGULATION 2013

ME6501 COMPUTER AIDED DESIGN SYLLABUS

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations homogeneous coordinates - Line drawing -Clipping- viewing transformation

UNIT II GEOMETRIC MODELING

Representation of curves- Hermite curve- Bezier curve- B-spline curves- rational curves-Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep.

UNIT III VISUAL REALISM

Hidden – Line-Surface-Solid removal algorithms – shading – colouring – computer animation.

UNIT IV ASSEMBLY OF PARTS

Assembly modelling – interferences of positions and orientation – tolerance analysis-massproperty calculations – mechanism simulation and interference checking.

UNIT V CAD STANDARDS

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchangeimages- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALSetc. - communication standards.

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007

REFERENCES:

R1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing
Management “Second Edition, Pearson Education, 1999

R2. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill
Book Co. Singapore, 1989

R3. Donald Hearn and M. Pauline Baker, “Computer Graphics”’. Prentice Hall, Inc, 1992

CO 1	Explain the Design process, Computer Aided Design concepts and Fundamentals of Computer Graphics
CO 2	Illustrate Geometric Modeling including Curves, Surfaces and Solids
CO 3	Explain the various aspects of Visual Realism
CO 4	Outline the concepts of Assembly Modeling including Tolerance Analysis
CO 5	Explain various types of CAD Standards
CO 6	Summarize various types of Data exchange Standards

CO Nos.		**Level of correlation* of the COs with the relevant POs/PSOs**						
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 6**	**PO 8**	**PSO1**	**PSO2**
CO 1	**2**	**1**	**-**	**-**	**2**	**3**	**3**	**2**
CO 2	**2**	**1**	**-**	**-**	**2**	**3**	**3**	**2**
CO 3	**2**	**1**	**-**	**-**	**2**	**3**	**3**	**2**
CO 4	**2**	**1**	**-**	**-**	**2**	**3**	**3**	**2**
CO 5	**2**	**1**	**-**	**-**	**2**	**3**	**3**	**2**
CO 6	**2**	**1**	**-**	**-**	**2**	**3**	**3**	**2**

UNIT-1

FUNDAMENTALS OF COMPUTER GRAPHICS

1.List out fundamentals of product life cycle management.

1. Customer Relationship Management (CRM)
2. Supply Chain Management (SCM)
3. Enterprise resource planning (ERP)
4. Product Planning and Development (PPD).

2. What is conceptualization in design process?

A Concept Study is the stage of project planning that includes developing ideas and taking into account the all features of executing those ideas. This stage of a project is done to reduce the likelihood of assess risks, error and evaluate the potential success of the planned project.

3. Define Product cycle.

Product cycle is the process of managing the entire life cycle of a product from starting, through design and manufacture, to repair and removal of manufactured products.

4. Differentiate preliminary design and detailed design. Preliminary design Detailed design

The preliminary design fills the gap between the design concept and the detailed design phase. The system configuration is defined, and schematics, diagrams, and layouts of the project will offer early project configuration. In detailed design and optimization, the parameters of the part being produced will change, but the preliminary design focuses on creating the common framework to construct the project. The next phase of preliminary design is the Detailed Design which may includes of procurement also. This phase builds on the already developed preliminary design, aiming to further develop each phase of the project by total description through drawings, modeling as well as specifications.

5.What is 'Rendering'?

Rendering is the making of a two dimensional image from a three dimensional model by means of computer programs. A picture file has objects in a strictly defined data structure; it would have information of geometry, lighting, viewpoint, texture, and shading as a description of the scene.

6. State the importance of Computer Architecture in CAD.

In CAD, Computer architecture is a set of disciplines that explains the functionality, the organization and the introduction of computer systems; that is, it describes the capabilities of a computer and its programming method in a summary way, and how the internal organization of the system is designed and executed to meet the specified facilities.

7. Define concurrent engineering and state it's advantages:
In concurrent engineering, various tasks are handled at the same time, and not essentially in the standard order. This means that info found out later in the course can be added to earlier parts, improving them, and also saving time. Concurrent engineering is a method by which several groups within an organization work simultaneously to create new products and services.
Advantages:
1.Both product and process design run in parallel and take place in the same time.
2. Process and Product are coordinated to attain optimal matching of requirements for effective
quality and delivery.
3. Decision making involves full team involvement.

8.What do you understand by the term 'Texture Mapping'?
Texture mapping is a system for providing detail, surface texture and color to a computer- generated graphic model. A texture map is used to the surface of a polygon. This process is like to sticking patterned paper to a plain white paper. Multi texturing is the use of more numbers of textures at a time on a polygon.

9. What are the steps involved in architecture implementation?
Computer architecture engages different aspects, including instruction set architecture design, logic design, and implementation. The implementation includes Integrated Circuit Design, Power, and Cooling. Optimization of the design needs expertise with Compilers, Operating Systems and Packaging.

10. Describe Computer Aided Design.
CAD is the function of computer systems to support in the creation, modification, analysis, or optimization of a design. CAD software is used to raise the productivity of the designer, progress the quality of design, progress communications through documentation, and to generate a database for manufacturing.

11. What are the steps involved in Conceptual Design?
i.Identification of customer needs

ii.Problem definition

iii.Gathering Information

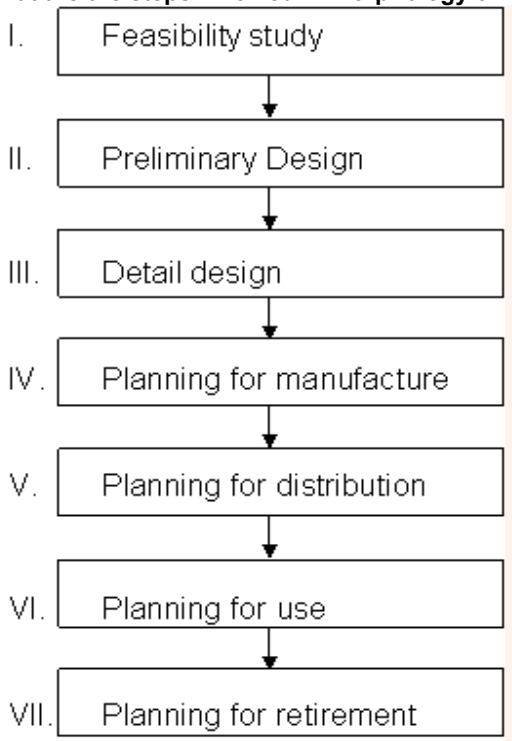
iv.Conceptual z t on

v.Concept selection

12. List some 2 –D and 3-D transformations.

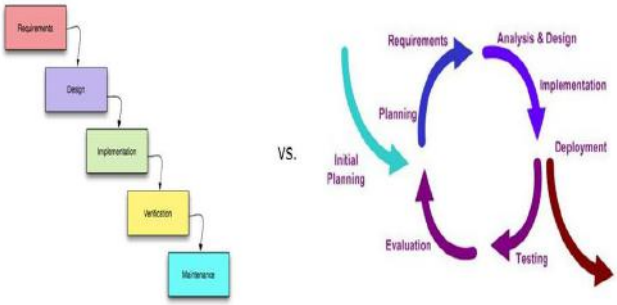
- Translation
- Rotation
- Scaling
- Mirroring
- Clipping

13. **What are the steps involved in Morphology of Design**



14. Define concurrent engineering

Concurrent engineering, also known as simultaneous engineering, is a method of designing and developing products, in which the different stages run simultaneously, rather than consecutively. It decreases product development time and also the time to market, leading to improved productivity and reduced costs.



15. What is CAD

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations.

16. **What is sequential Engineering?**

Traditional engineering, also known as sequential engineering, is the process of marketing, engineering design, manufacturing, testing and production where each stage of the development process is carried out separately, and the next stage cannot start until the previous stage is finished.

17. What are stages of cad (or) design related activities performed by cad (or) elements of cad (or) applications of computers for design

The various design related tasks which are performed by a modern computer aided design system can grouped into four functional areas:

I. Geometric Modeling
II. Engineering Analysis
III. Design Review and Evaluation
IV. Automated Drafting

18. List down the types of computer graphics

I. Passive Computer graphics
II. Interactive Computer graphics

19. What is concatenation transformation?

It is a single transformation by combining many transformations linked one after the other to perform the final task

20. How does Bresenham's method differ from DDA algorithm

Integer Arithmetic. DDA algorithm uses multiplication and division in its operations. Bresenhams algorithmuses only subtraction and addition in its operations.DDA algorithm is rather slowly than Bresenhams algorithm in line drawing because it uses real arithmetic (floating-point operations)

21. What is Homogeneous Coordinates?

Homogeneous coordinates are ubiquitous in computer graphics because they allow common vector operations such as translation, rotation, scaling and perspective projection to be represented as a matrix by which the vector is multiplied.

Part-B

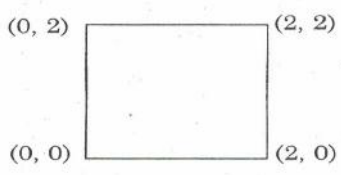
1. Explain briefly about Product Cycle and Design Process

2. Distinguish Between Conventional Design and Computer Aided Design system with CAD architecture
3. Explain briefly about Concurrent and Sequential Engineering

4. What is a geometric transformation? Define and explain the following With respect to 3-D transformations : Translation (ii) rotation (iii) scaling (iv) reflection
5. What are the 2-D transformations? Explain each types

6. What are the 3-D transformations? Explain each types
7. What are different types of geometric modeling

8. Write short notes on Clipping and Line Drawing with an examples
9. Write short notes on
   i. Design Process
   ii. Role of CAD in the Design Process.
10. Rotate the rectangle shown below, by 30° counter clockwise about its centroid and find the New coordinates of the rectangle



11. Given the triangle with the homogeneous coordinates (2 2 0 1), (2 5 0 1) and (5 5 0 1) , scale it by a factor 3/4 by keeping the centroid in the same location
12. With the help of a flow chart, explain the Morphology of Engineering Systematic Design process. How CAD tools will help in this process?
13. Explain Cohen and Sutherland 2D clipping algorithm.

14. What is two dimensional Clipping? Explain Cohen and Sutherland 2D clipping algorithm.
15. Explain briefly about the Viewing Transformation

8 Marks

1. Write short notes on Homogeneous coordinates
2. Explain the Co ordinates Systems
3. What are the advantages of CAD in design? Explain application of Computers to the design process
4. Briefly explain the benefits of computer aided Design
5. Write short notes on Computer Graphics and types

UNIT-2
GEOMETRIC MODELING

1. Write down the advantages of surface modeling.

- Surface modeling can be used to check the real look of the product with coloring and shading.
- Surface modeling can be used to perform interference checking.
- As the surface models precisely define the part geometry such as surface and boundaries, they can help to produce machine instructions automatically.
- Complex surface features can be created very easily.
- Un ambiguities in the interpretation of object is less than wire frame models by using the provision of hidden line removal.

2. What is CGS?

Constructive solid geometry (CSG) is a method used in solid modeling for creating 3D models in CAD. Constructive solid geometry permits a modeler to make a complex surface by applying Boolean operators to join objects. Frequently CSG presents a model/surface that appears visually complex, but is essentially little more than cleverly combined.

3. Write down two important solid modeling technique.

The solid modeling techniques permit for the automation of some complicated engineering calculations that are approved as a part of the design progression. Simulation, planning, and confirmation of processes such as machining and assembly were one of the initiations for the development of solid modeling technique.

4. Write down 'Free form surface'.

Freeform surface is used in CAD and other computer graphics software to describe the skin of a 3D geometric element. Freeform surfaces do not have rigid radial dimensions, unlike regular surfaces such as planes, cylinders and conic surfaces.

5. Define 'focus' of a curve.
In geometry, the focus is pair of special points with reference to which any of a variety of curves is constructed.

6. Write a short note 'Hermite curve'.
A Hermite curve is a spline where every piece is a third degree polynomial defined in Hermite form: that is, by its values and initial derivatives at the end points of the equivalent domain interval.

7. Define Conic section.
A conic section is a curve created as the intersection of a cone with a plane. In analytic geometry, a conic may be described as a plane algebraic curve of degree two, and as a quadric of dimension two.

8. Write down the eccentricity value for ellipse, parabola and hyperbola.
The value of eccentricity less than one is ellipses, those with eccentricity equal to one are parabolas, and those with eccentricity greater than one is hyperbolas.

9. Define Quadratic Bezier curve.
As shown in the figure, a quadratic Bezier curve is the path defined by the function B(t), given points P0, P1, and P2,B(t)={(1-t) (1-t)P0=tp1=t(1-t)p1=tp2}

10. List out properties of B-Spline.
- The maximum order in every parametric direction is limited to the number of describing polygon vertices in that path.
- The surface is changeable to an affine transformation.
- The deviation diminishing property of B-spline surface is not well recognized.
- The control of any polygon net vertex is limited to ±p/2, ±q/2 spans in the particular parametric direction.
- If the number of polygon net vertices is equal to the order of basis in that dire.

11. Write the equation of a circle in parametric form
A circle with its centre at the orgin and radius = 1 can be written in implicit form given by

$$F(x,y)=x^2 + y^{2=}0$$

Or in parametric form given by

$X,y=f(\theta)=\cos \theta,\sin \theta$ Where θ is the parametric variable

12. Mention the various limitation of using wire frame models
Disadvantages of Wireframe model:
a) Image causes confusion
b) Cannot get required information from this model

c) Hidden line removal features not available
d) Not possible for volume and mass calculation, NC programming cross sectioning etc
e) Not suitable to represent complex solids

13. What are the types of curve continuities?
(i) Geometric
(ii) Parametric

14. State the approach to model synthetic curve
a) Interpolation and
b) Approximation

15. Differentiate between analytical curves, interpolated curves, and approximated curves.
Analytical curve: This type of curve can be represented by a simple mathematical equation such as circle or ellipse. They have fixed form and cannot be modified to achieve a shape that violates the mathematical equation.
Interpolated curve: An interpolated curve is drawn by interpolating the given data points, dictated by the given data points. These curves have some limited flexibility in shape creation, dictated by the data points.
Approximated curves: These curves provide the most flexibility in drawing curves of very complex shapes. The model of a curved automobile fender can be easily created with the help of approximated curves and surfaces.

16. Differentiate CSG and B-Rep Models.
CSG refers to Constructive Solid Geometry. It uses standard primitives like Block, Cylinder, Cone, Cube etc. shapes and solid model can be generated by using Boolean operations of Addition, Subtraction, Union, Intersection etc.
In B-Rep or Boundary Representation Models, Vertex, edges, faces, surfaces will be defined using Euler's equation and building the blocks with representation of these entities.

17. **What do you mean by Sculptured surface?**
Sculptured surfaces are used in geometric modeling to describe all sorts of bendy things like aero plane wings, car bodies, gas-turbine blades, ship's hulls and so on that can't be described by simple curved surfaces such as cylinders and cones.. These complex surfaces are known as sculptured or free-form surfaces.

18. **What is surface segmentation?**
Surface segmentation is a reparametrization or parameter transformation of the surface while keeping the degree of its polynomial in u and v unchanged. Efficient segmentation of globally optimal surfaces representing object boundaries in volumetric data sets is

important and challenging in many medical image analysis applications. Surface segmentation is employed in BIW (Body in White) automotive modeling

19. **What are rational curves importances?**
A rational curve is defined by algebraic ratio of two polynomials. A parametric curve in homogeneous form is referred to as a *rational curve*. They draw their theories from projective geometry. Importance is under projective transformation that is the perspective image of a rational curve is a rational curve.

Space curve: F(*u*) = (*x*(*u*), *y*(*u*), *z*(*u*), *w*(*u*))
Plane curve : F(*u*) = (*x*(*u*), *y*(*u*), *w*(*u*))
Where *u* is a parameter in some closed interval [*a*, *b*]

20. What is Bezier surface?
A tensor product Bezier surface is an extension of the Bezier curve in two parametric directions u and v. Bezier surface allows only global control of the surface. Bezier surface is formed as the Cartesian product of the blending functions of two orthogonal Bezier curves and is defined by a set of control points. A two-dimensional Bezier surface can be defined as a parametric surface where the position of a point has a function of the parametric coordinates u, v.

21. What are the characteristics of B-spline surface?
A rectangular set of data or control points creates the surface. It is the general surface as Bezier surface but with the advantage of permitting local control of the surface. This set forms the vertices of the characteristic polyhedron that approximates and controls the shape of the resulting surface. The degree of the surface is independent of the number of control points and continuity is automatically maintained throughout the surface by virtue of the form of blending functions.

22. What are the limitations of Hermite Curve?
The curve follows the cubic polynomial and hence the number of control points is only three. With three control points, complicated shapes cannot be produced. Hence it has its limitations in constructing.

23. What do mean by intersection in surface?
The intersection problem involving surfaces is complex and non-linear in nature. It depends on whether it is a surface/curve or surface/surface interaction as well as on the representation, parametric or implicit of the surface or curves.

Part-B

1 What are different types of geometric modeling
2 Explain briefly about Solid modeling Techniques
3 What are difference between surface modeling and solid modeling
4 Write short note on CSG and B"rep of solid modeling Techniques
5 Write short note on Constructive Solid Geometry (CSG)
6 Describe neatly the various types of wire surface and solid modeling approaches
7 Discuss the matrix formulation in Cubic B-Spine curve
8 Briefly discuss about the Hermite and Bezier curve
9 Given the control points [1 1], [2 3], [4 3] and [3 1] the vertices of a Bezier polygon, determine five points on the Bezier curve.
10 Write a note on: i. NURBS ii. B-splines.
11 What are the Solid Modeling Techniques? And Explain in detail about B-rep
12 Describe Image space method with a suitable algorithm.
13 Explain the Representation of curves.
14 Differentiate between Bezier and B- spline surface with reference to number of control points, order of continuity and surface normal.
15 Discuss the modeling guidelines to be followed by the user while constructing a surface model as a CAD/CAM system.
16 How does solid modellimg differ from surface modeling?with neat sketch discuss briefly about B-rep type of solid modeling techniques
17 A set of control points is given by P_0=(4,4,4), P_1 = (6,8,6) , P_2 = (10,3,4) Compute Bezier curve with two intermediate points

UNIT-3
VISUAL REALISM

1. What is the need of visualization?

Visualization in geometric modeling is helpful in finding connection in the design applications. By shading the parts with various shadows, colors and transparency, the designer can recognize undesired unknown interferences. In the design of complex surfaces shading with different texture characteristics can use to find any undesired quick modifications in surface changes.

2. What is hidden solid removal?

The hidden solid removal problem involves the view of solid models with hidden line or surface eliminated. Available hidden line algorithm and hidden surface algorithms are useable to hidden solid elimination of B-rep models.

3. What is powder shading?

Powder shading is a sketching shading method. In this style, the stumping powder and paper stumps are used to draw a picture. This can be in color. The stumping powder is smooth and doesn't have any shiny particles. The poster created with powder shading looks more beautiful

than the original. The paper to be used should have small grains on it so that the powder remains on the paper.

4. Mention the advantages and limitations of ray tracking algorithm.

Advantages of Ray tracing:

1 A realistic simulation of lighting over other rendering.
2 An effect such as reflections and shadows is easy and effective.
3 Simple to implement yet yielding impressive visual results.

Limitation of ray tracing:

Scan line algorithms use data consistency to divide computations between pixels, while ray tracing normally begins the process a new, treating every eye ray separately.

5. What is hidden line removal?

Hidden line removal (HLR) is the method of computing which edges are not hidden by the faces of parts for a specified view and the display of parts in the projection of a model into a 2D plane.

6. What is hidden solid removal?

The hidden solid removal problem involves the view of solid models with hidden line or surface eliminated. Available hidden line algorithm and hidden surface algorithms are use able to hidden solid elimination of B-rep models.

7. List out the various visualization approaches.

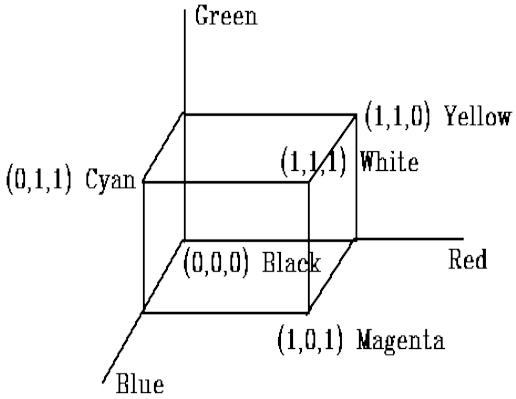
- Parallel projections
- Perspective projection.
- Hidden line removal
- Hidden surface removal
- Hidden solid removal
- Shaded models

8. Mention any two surface removal algorithm.

1. Z - buffer algorithm
2. Painters algorithm

9. State the salient features of RGB colour space

A RGB color space is any additive color space based on the RGB color model. A particular RGB color space is defined by the three chromaticities of the red, green, and blue additive primaries, and can produce any chromaticity that is the triangle defined by those primary colors.



10. Name the hidden line removal algorithms

a) Plane Sweep Paradigm,
b) Priority Algorithm,
c) Over-Lay Algorithm,
d) Area Oriented Algorithm

11. What is coherence?

The elements of a scene or its image have some interrelationships called as coherence. It is the measure how rapid a scene or its image changes and describes the extent to which a scene or its image is locally constant. This visual coherence may provide the user with stronger visual cues on the location, shape and characteristics of the virtual objects, and of the interactions between them and the real objects

12. Define Key framing

A keyframe in animation and filmmaking is a drawing that defines the starting and ending points of any smooth transition. The drawings are called "frames" because their position in time is measured in frames on a strip of film. A sequence of keyframes defines which movement the viewer will see, whereas the position of the keyframes on the film, video, or animation defines the timing of the movement. Because only two or three keyframes over the span of a second do not create the illusion of movement, the remaining frames are filled with inbetweens.

13. List out various visualization approaches

Hidden removal algorithms
Line removal algorithms
Surface removal algorithms
Solid removal algorithms
Shading
Colouring
Computer animation.

14. What are improvements brought by gouraund shading compared with other shading techniques?

Gouraud shading, named after Henri Gouraud, is an interpolation method used in computer graphics to produce continuous shading of surfaces represented by polygon meshes. In practice, Gouraud shading is most often used to achieve continuous lighting on triangle surfaces by computing the lighting at the corners of each triangle and linearly interpolating the resulting colours for each pixel covered by the triangle. Gouraud first published the technique

15. **Mention the importance of colouring of three dimension objects in computer graphics**

3D computer graphics or three-dimensional computer graphics, (in contrast to 2D computer graphics) are graphics that use a three-dimensional representation of geometric data (often Cartesian) that is stored in the computer for the purposes of performing calculations and rendering 2D images. Such images may be stored for viewing later or displayed in real-time.

16. **4. Differentiate Phong shading and Gourand shading**

Phong shading	Gourand shading
Phong shading is interpolation of normal vectors at vertices and apply shade models Phong shading produces sharp shades with high intensity	Gourand shading is form of intensity interpolation or first-derivative sahding Gourand shading produces smooth shades
Computational time is high	Computational time is low

17. **What is Warnock's Algorithm?**

This is one of the first area-coherence algorithms. The Warnock algorithm is a hidden surface algorithm invented by John Warnock that is typically used in the field of computer graphics Essentially, this algorithm solves the hidden surface problem by recursively subdividing the image into sub images. It first attempts to solve the problem for a window that covers the entire image

18. **What are Silhouettes?**

A set of edges that separates visible faces from invisible faces of an object with respect to a given viewing direction is called silhouette edges (or silhouettes). An edge that is part of silhouette is characterized as the intersection of one visible face and one invisible face.

19. **Write short notes on "Z" buffer algorithm.**

This is also called as depth-buffer algorithm. This algorithm requires a z-buffer in which z values can be sorted for each pixel. The z buffer is

initialized to the smallest value of z while the frame buffer is initialized to the background pixel value.

20. **What is the purpose of the containment test?**
Some hidden lines algorithms depend on whether a polygon surrounds a point or another polygon. The containment test checks whether a given point lies inside a given polygon or polyhedron.

21. **What is shading? List the shading models**
Shaded color images covey shape information that cannot be represented in line drawings. Shaded images can also convey features other than shape such as surface finish or material type. a) Diffuse Reflection; b) Specular Reflection; c) Ambient Light

22. **What is colouring and enumerate the colouring models?**
Colours can be used in geometric construction and distinguishing the wireframe, surface or solid entities by assigning different colors.
RGB (Red, Green, Blue) Model
CMY (Cyan, Magenta, Yellow) Model
YIQ Model

23. What are the basics requirements for engineering animation system?

1. It is required to obtain real time generation of images
2. Novice users need an engineering animation system to provide easy to use interactive environment to make and modify animation
3. Exploded view animation is needed to help explain assembly / disassembly parts
4. SOLID WORKS motion is needed to rotate , slide and move components to our convenient

PART-B

1. Explain briefly with sketches any six tests used for hidden line identification.
2. Explain briefly Phong shading and Gouraud shading.
3. Explain outline the steps required to generate a hidden-surface image using the depth-buffer approach and then comment on the relative merits of this approach compared with the scan-line algorithm.
4. Explain the surface algorithms for surface hidden removal of an abject.
5. Write note on sample hidden line algorithms.
6. Explain the area oriented algorithm and Priority algorithm for hidden line removal.
7. Write note on Ray/Primitive intersection module of ray tracing algorithm.
8. Explain briefly RGB and CMY color model.

9. Write notes on Frame-Buffer animation and animation techniques with an example.
10. Explain key frame technique of computer animation with an example.
11. Explain how position and orientation are interpolated in animation process
12. Descibe an algorithm for removal of the line surface. Also illustrate with an example how the algorithm can be implemented
13. Explain the depth-buffer algorithm for hidden surface removal
14. Explain the procedure to compute the z-values in two successive locations in a scan – line and intersection position on two successive scan lines
15. Explain the Hidden-solid Removal Ray-Tracing algorithm with suitable examples

UNIT IV
ASSEMBLY OF PARTS

1. **What is meant by assembly modelling?**
   It is a technology and method used by CAD systems to handle multiple files which represent the components within a product.
2. **What are the various assembly modelling approaches?**
   Bottom up, Top down and combination of these.
3. **What is meant by constraints?**
   They refer to the geometric or mathematical rules which are applied to restrict the location of parts in the assembly model.
4. **What are the various mating conditions used in assembly modelling?**
   Parallel, perpendicular, symmetric etc.,
5. **What are the techniques used in the evaluation of assembly sequence?**
   Precedence diagram, liaison sequence analysis and precedence graph.
6. **What is meant by tolerance?**
   It is the amount of variation permitted to the basic size.
7. **What is meant by deviation?**
   It is the difference between the actual size and the basic size.
8. **What is meant by fundamental deviation?**
   It is either the upper or lower deviation nearer to the zero line and chosen to refer the position of tolerance zone.
9. What is a basic hole?
   It is a hole for which the lower deviation is zero.
10. **What is meant by hole basis system?**
    In this, the hole size is kept constant and the shaft size is varied to get the required fit.

11. **What is unilateral tolerance?**
    It is a tolerance in which variation is permitted only in one direction from the specified direction.
12. **What is meant by fit?**
    It refers to the relative tightness or looseness between the two mating parts.
13. **What are the various types of fits?**
    Clearance fit, interference fit and transition fit.
14. **What is meant by preferred numbers?**
    They are the numbers which are got by geometric progression with specific step ratios.
15. **What is meant by tolerance analysis?**
    The process of checking the tolerances to verify whether all the design constraints are met is called as tolerance analysis.
16. **What are the methods of tolerance analysis?**
    Worst case arithmetic, worst case statistical and monte carlo simulation method.

Part -B

1. Describe bottom up and top down assembly with example.
2. Derive the interference free matrix with example.
3. Explain tolerance stack-up with example.
4. Describe RSS for tolerance analysis with RSS cube.
5. Discuss importance of tolerance analysis.
6. Explain the calculating method for center of gravity.
7. Describe the calculation of moment of inertia.
8. List out and describe various mass properties for a cross section.
9. Explain virtual simulation.
10. Discuss the applications of simulation.

UNIT V
CAD STANDARDS

1. **What are the various elements of cad/cam structure?**
   Application data, application program, graphics system and application data input/output device.

2. **What is meant by database?**
   It is a collection of data at a single location to be used by various people for different applications.

3. **What the various objectives of database?**
   It reduces redundant data, It integrates the existing data, It provides security and It shares the data among the users.

4. **What is the need of graphic standards?**
   It is mainly used to exchange graphic data between different computer systems.

5. **What are the various interface standards available?**
   GKS, PHIGS, STEP, IGES,DXF etc.,

6. **What is meant by topological information?**
   It is the information about the product through solid modelling.

7. **What are the classifications of CAD standards?**
   Graphics and computing standards, data exchange standards and communication standard.

8. **What is meant by GKS?**
   It is basically a set of procedures which can be called by user programs to carry out certain generalized functions such as arc, circle etc.,

9. **What are the different coordinates used in GKS?**
   World coordinates, Normalized device coordinates and device coordinates.

10. **What is a Core system?**
    The standardization of graphic system is called a core system.

11. **What are the basic items of an object in GKS?**
    Primitives and attributes.

12. **Define – Primitives**
    In GKS, pictures are considered to be constructed from a number of basic building blocks called as primitives.

13. **What are the output primitives in GKS?**
    Polyline, polymakers, text and fill area.

14. **What are the various input methods in GKS?**
    String, choice, valuator and locator.

15. **What are the approaches used in data exchange format?**
    Shape based format and product data based format.

16. **What are the various file sections in IGES?**
    Flag, Start section, Global section, Directory section, Parameter data section and Termination section.

17. What are the various methods of data exchange.
Direct CAD system export/import, Direct translation software and neutral data exchange format.

18. What are the reasons of exchanging data?
For using the same CAD package across different systems and to use a neutral format for data exchange.

19. What are the logical concepts involved in GKS?
Logical input modes, logical workstation, GKS metafiles and GKS – 3D.

20. What are the logical concepts involved in PHIGS?
Structure networks and manipulation, logical input device, search and enquiry, structure transversal and display and graphic output.

PART – B

1. Describe graphics standards in graphics programming.
2. Explain various layers of GKS.
3. Explain OpenGL with schematic diagram.
4. Discuss Data exchange standards in detail.
5. Describe the structure of IGES file.
6. Explain IGES entities with format.
7. Explain IGES common testing methods.
8. Explain STEP architecture with neat sketch.
9. Compare CGM and CGI.
10. Explain about continuous acquisition and life cycle support

ME6502- HEAT AND MASS TRANSFER

ME6502- HEAT AND MASS TRANSFER SYLLABUS

UNIT I CONDUCTION

General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT II CONVECTION

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS

Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.

UNIT IV RADIATION

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

UNIT V MASS TRANSFER

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations.

Text Book(s):

T1. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 2010

Reference Book(s):

R1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998
R2. Venkateshan. S.P., "Heat Transfer", Ane Books, New Delhi, 2004.
R3. Ghoshdastidar, P.S, "Heat Transfer", Oxford, 2004,

R4. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002
R5. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000
R6. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
R7. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
R8. Yadav, R., "Heat and Mass Transfer", Central Publishing House, 1995.
R9. M.Thirumaleshwar : Fundamentals of Heat and Mass Transfer, "Heat and Mass Transfer", First Edition, Dorling Kindersley, 2009

Course Outcomes:

CO1 Explain the mechanism of heat transfer under steady state, transient condition & its problems

CO2 Apply the concept of heat transfer through extended surfaces

CO3 Solve the problem in the convection of heat transfer through internal and external flow.

CO4 Utilize the boiling and condensation concepts for solving the problem.

CO5 Analyze the various flows of heat exchanger

CO6 Choose different analytical techniques in solving the problem of radiant heat transfer

CO7 Make use of different relations for the mass transfer rate depending upon the conditions

CO Nos.		Level of correlation* of the COs with the relevant POs/PSOs						
	PO 1	PO 2	PO 3	PO 4	PO 6	PO 8	PSO1	PSO2
CO 1	3	3	2	2	-	-	2	1
CO 2	3	3	2	2	-	-	2	1
CO 3	3	3	2	2	-	-	2	1
CO 4	3	3	2	2	-	-	2	1
CO 5	3	3	2	2	-	--	2	1
CO 6	3	3	2	2	-	-	2	-

UNIT I CONDUCTION

PART A

1. State Fourier's Law of conduction. NOV-DEC 13 & 14

The rate of heat conduction is proportional to the area measured – normal to the direction of heat flow and to the temperature gradient in that direction.

2. Define Thermal Conductivity.

Thermal conductivity is defined as the ability of a substance to conduct heat.

3. Write down the equation for conduction of heat through a slab or plane wall.

Heat transfer $Q = \Delta T/R$

4. State Newton's law of cooling or convection law.

Heat transfer by convection is given by Newton's law of cooling

5. Define overall heat transfer co-efficient.

The overall heat transfer by combined modes is usually expressed in terms of an overall conductance or overall heat transfer co-efficient 'U'.

Heat transfer $Q = UA \Delta T$.

6. What is critical radius of insulation (or) critical thickness?

Addition of insulating material on a surface does not reduce the amount of heat transfer rate always. In fact under certain circumstances it actually increases the heat loss up to certain thickness of insulation. The radius of insulation for which the heat transfer is maximum is called critical radius of insulation, and the corresponding thickness is called critical thickness.

7. Define fins (or) extended surfaces.

It is possible to increase the heat transfer rate by increasing the surface of heat transfer. The surfaces used for increasing heat transfer are called extended surfaces or sometimes known as fins.

8. State the applications of fins.

The main applications of fins are

1. Cooling of electronic components
2. Cooling of motor cycle engines.
3. Cooling of transformers
4. Cooling of small capacity compressors

9. Define Fin efficiency.
The efficiency of a fin is defined as the ratio of actual heat transfer by the fin to the maximum possible heat transferred by the fin.

10. Define Fin effectiveness.
Fin effectiveness is the ratio of heat transfer with fin to that without fin

11. Define fins or extended surfaces
It is possible to increase the heat transfer rate by increasing the surface of heat transfer .the surfaces used for increasing heat transfer are called extended surfaces or sometimes known as fins.

12. State the applications of fins
1. Cooling of electronic components
2. Cooling of motor cycle engines
3. Cooling of transformers
4. Cooling of small capacity compressors

13. What is periodic heat flow?
In periodic heat flow the temperature varies on a regular basis. e.g;
1. Cylinder of an IC engine
2. Surface of earth during a period of 24 hours

14. What is non-periodic heat flow?
In non periodic heat flow the temperature at any point within the system varies non linearly with time. e.g;
1. Heating of ingot in a surface
2. Cooling of bar

15. What is meant by Newtonian heating or cooling process?
The process in which the thermal resistance is assumed as negligible in comparison with its surface resistance is known as Newtonian heating or cooling process

16. What is meant by lumped heat analysis?
In a Newtonian heating or cooling process the temperature throughout the solid is considered to be a uniform at a given time. Such an analysis is called lumped heat capacity analysis

17. What is meant by semi infinite solids?
In a semi infinite solid at any instant of time, there is always a point where the effect of heating or cooling at one of its boundaries is not felt at all. At this point the temperature remains unchanged. In semi-infinite solids the biot number value is ∞

18. What is lumped system analysis? When is it applicable? [NOV-DEC 14]

In heat transfer analysis, some bodies are observed to behave like a "lump" whose entire body temperature remains essentially uniform at all times during a heat transfer process. The temperature of such bodies can be taken to be a function of time only. Heat transfer analysis which utilizes this idealization is known as the lumped system analysis. It is applicable when the Biot number (the ratio of conduction resistance within the body to convection resistance at the surface of the body) is less than or equal to 0.1

19. In what medium is the lumped system analysis more likely to be applicable: in water or in air? why?

The lumped system analysis is more likely to be applicable in air than in water since the convection heat transfer coefficient and thus the Biot number is much smaller in air.

20. What is a semi-infinite medium? Give examples of solid bodies that can be treated as semi-infinite mediums for heat transfer purposes.

A semi-infinite medium is an idealized body which has a single exposed plane surface and extends to infinity in all directions. The earth and thick walls can be considered to be semi-infinite media.

PART – B

1. A pipe consists of 100 mm internal diameter and 8mm thickness carries steam at 170°C. The convective heat transfer coefficient on the inner surface of pipe is 75 W/m2C. The pipe is insulated by two layers of insulation. The first layer of insulation is 46 mm in thickness having thermal conductivity of 0.14 W/m°C. The second layer of insulation is also 46 mm in thickness having thermal conductivity of 0.46 W/m°C. Ambient air temperature = 33°C. The convective heat transfer coefficient from the outer surface of pipe = 12 W/m2C. Thermal conductivity of steam pipe = 46 W/m°C. Calculate the heat loss per unit length of pipe and determine the interface temperatures. Suggest the materials used for insulation.

2. A long rod is exposed to air at 298°C. It is heated at one end. At steady state conditions, the temperatures at two points along the rod separated by 120 mm are found to be 130°C and 110°C respectively. The diameter of the rod is25mmOD and its thermal conductivity is 116 W/m°C. Calculate the heat transfer coefficient at the surface of the rod and also the heat transfer rate.

3.(i) A furnace wall consists of three layers. The inner layer of 10 cm thickness is made of firebrick (k =1.04 W/mK). The intermediate layer of 25 cm thickness is made of masonry brick (k = 0.69 W/mK) followed by a 5 cm thick concrete wall (k = 1.37 W/mK). When the furnace is in continuous operation the inner surface of the furnace is at 800°C while the outer concrete surface is at 50°C. Calculate the rate of heat loss per unit area of the wall, the temperature at the interface of the firebrick and masonry brick and the temperature at the interface of the masonry brick and concrete. (8)

(ii) An electrical wire of 10 m length and 1 mm diameter dissipates 200 W in air at 25°C.The convection heat transfer coefficient between the wire surface and air is 15 W/m2K.Calculate the critical radius of insulation and also determine the temperature of the wire if it is insulated to the critical thickness of insulation. (8)

4. (i) An aluminium rod (k =204 W/mK) 2 cm in diameter and 20 cm long protrudes from a wall which is maintained at 300°C. The end of the rod is insulated and the surface of the rod is exposed to air at 30°C. The heat transfer coefficient between the rod's surface and air is 10W/m^2K. Calculate the heat lost by the rod and the temperature of the rod at a distance of 10 cm from the wall. (7)

(ii) A large iron plate of 10 cm thickness and originally at 800°C is suddenly exposed to an environment at O°C where the convection coefficient is 50 W/m2K. Calculate the temperature at a depth of 4 em from one of the faces 100 seconds after the plate is exposed to the environment. How much energy has been lost per unit area of the plate during this time?

5.(i) Explain the different modes of heat transfer with appropriate expressions. (6)

(ii) A composite wall consists. of 10 cm thick layer of building brick, k = 0.7 W/mK and 3 cm thick plaster, k = 0.5 W/mK. An insulating material of k = 0.08 W/mK is to be added to reduce the heat transfer through the wall by 40%. Find its thickness. (10)

6. Circumferential aluminium fins of rectangular profile (1.5cmwide and 1mm thick) are fitted on to a 90 mm engine cylinder with a pitch of 10 mm. The height of the cylinder is 120 mm. The cylinder base temperature before and after fitting the fins are 200°C and

150°C respectively. Take ambient at 30°C and h(average) =100 W/m2K. Estimate the heat dissipated from the finned and the unfinned surface areas of cylinder body. (16)

7. (i) Derive the heat conduction equation in cylindrical co-ordinates using an elemental volume for a stationary isotropic solid. (8)

(ii) A 3 cm OD steam pipe is to be covered with two layers of insulation each having a thickness of 2.5 cm. The average thermal conductivity of one insulation is 5 times that of the other. Determine the percentage decrease in heat transfer if better insulating material is next to pipe than it is the outer layer. Assume that the outside and inside temperatures of composite insulation are fixed. (8)

8. (i) Explain briefly the concept of critical thickness of insulation and state any two applications of the same. (8)

(ii) A 6 em long copper rod (k = 300 W/mK) 6mm in diameter is exposed to an environment at

20°C. The base temperature of the rod is maintained at 160°C. The heat transfer co-efficient is 20 W/m2K. Calculate the heat given by the rod and efficiency and effectiveness of the rod. (8)

9. (i) Define the Biot and Fourier numbers. (4)

(ii) What is meant lumped capacity? What are the physical assumptions necessary for a lumped capacity unsteady state analysis to apply? (4)

(iii)A slab of Aluminium 5 cm thick initially at 200°C is suddenly immersed in a liquid at 70°C for which the convection heat transfer co-efficient is 525 W/m2K. Determine the temperature at a depth of 12.5 mm from one of the faces 1 minute after the immersion. Also calculate the energy removed per unit area from the plate during 1 minute of immersion. Take P = 2700 bar, C_p = 0.9 kJlkg. OK, k=215W/mK, ά = 8.4X 10-5 m2/s.(8)

10. A composite wall is formed of a 2.5 cm copper plate (k = 355 W/m.K), a 3.2 mm layer of asbestos (k = 0.110 W/m.K) and a 5 cm layer of fibre plate (k = 0.049 W/m.K). The wall is subjected to an overall temperature difference of 560°C (560°C on the Cu plate side and O°C on the fiber plate side). Estimate the heat flux through this composite ~all and the interface temperature between asbestos and fibre plate. (16)

11. A steel tube k=43.26 W/mK of 5.08 cm 10 and 7.62 cm 00 is covered with 2.54 cm of asbestos insulation k=0.208 W/Mk. The inside surface of the tube receives heat by convection from a hotgas at a - temperature of 316°C with heat transfer coefficient ha=284 W/m2K while the outer surface of Insulation is exposed to atmosphere air at 38°C with heat transfer coefficient of 17W/m^2K Calculate heat loss to atmosphere for 3 m length of the tube and temperature drop across each layer. (16)

12. (i) A plane wall 20 cm thickness generates heat at the rate of 5 x 10^4 W/m^3 when an electric current is passed through it. The convective heat transfer coefficient between each face of the wall and the ambient air is 60 W/m2K. Determine.

(i) The surface temperature (4)

(ii) The maximum temperature in the wall. Assume ambient air temperature to be 25°C and the thermal conductivity of the wall material to be 16 W/mK. (4)

(ii) A steel ball 100 mm diameter was initially at 50~C and is placed in air which is at 35°C. Calculate time required to attain 400°C and 300°C. (8) k steel = 35 W/mK c = 0.46 kJ/kgK p = 7800 kg/m^3 h = 10 W/m^2K

UNIT II CONVECTION

Two Marks Question with Answers:

1. **Define – Convection (Nov/Dec-2012)**

   Convection is a process of heat transfer that will occur between a solid surface and a fluid medium when they are at different temperatures.

2. **Define – Nusselt number (Nu) (Nov/Dec-2012)**

   It is defined as the ratio of the heat flow by convection process under an unit temperature gradient to the heat flow rate by conduction under an unit temperature gradient through a stationary thickness (L) of meter.

3. **What is meant by laminar flow and turbulent flow? (A/M-2012)**

   Laminar flow: Laminar flow is sometimes called stream line flow. In this type of flow, the fluid moves in layers and each fluid particle follows a smooth continuous path. The fluid particles in each layer remain in an orderly sequence without mixing with each other.

Turbulent flow: In addition to the laminar type of flow, a distinct irregular flow is frequency observed in nature. This type of flow is called turbulent flow. The path of any individual particle is zig – zag and irregular. Fig. shows the instantaneous velocity in laminar and turbulent flow.

4. What is meant by free or natural convection & forced convection? (April/May-2012)

If the fluid motion is produced due to change in density resulting from temperature gradients, the mode of heat transfer is said to be free or natural convection.

If the fluid motion is artificially created by means of an external force like a blower or fan, that type of heat transfer is known as forced convection.

5.. Define – Reynolds number (Re) , Prandtl number (Pr) (Nov/Dec-2011)

Reynolds number is defined as the ratio of inertia force to viscous force.

Prandtl number is the ratio of the momentum diffusivity of the thermal diffusivity.

$$Pr = \frac{\text{Momentum diffusivity}}{\text{Thermal diffusivity}}$$

6. Define – Grashoof number (Gr) , Stanton number (St) (Nov/Dec-2011)

It is defined as the ratio of product of inertia force and buoyancy force to the square of viscous force.

Stanton number is the ratio of nusselt number to the product of Reynolds number and prandtl number.

7. What is meant by Newtonian and non – Newtonian fluids? (April/May-2011)

The fluids which obey the Newton's Law of viscosity are called Newtonian fluids and those which do not obey are called non – Newtonian fluids.

8. Define boundary layer thickness. (April/May-2011)

The thickness of the boundary layer has been defined as the distance from the surface at which the local velocity or temperature reaches 99% of the external velocity or temperature.

9. What is the form of equation used to calculate heat transfer for flow through cylindrical pipes? (April/May-2008)

$$Nu = 0.023 (Re)^{0.8} (Pr)^{n}$$

n = 0.4 for heating of fluids n = 0.3 for cooling of fluids

10. What is meant by dimensional analysis? (Nov/Dec- 1996)

Dimensional analysis is a mathematical method which makes use of the study of the dimensions solving several engineering problems. This method can be applied to all types of fluid resistances, heat flow problems in fluid mechanics and thermodynamics.

11. What is hydrodynamic boundary layer?

In hydrodynamic boundary layer, velocity of the fluid is less than 99% of free stream velocity.

12. What is thermal boundary layer ?

In thermal boundary layer, temperature of the fluid is less than 99% of free stream temperature

13. Define convection.

Convection is a process of heat transfer that will occur between a solid surface and a fluid medium when they are at different temperatures

14. What is meant by free or natural convection?

If the fluid motion is produced due to change in density resulting from temperature gradients, the mode of heat transfer is said to be free or natural convection.

15. What is forced convection?

If the fluid motion is artificially created by means of an external force like a blower or fan, that type of heat transfer is known as forced convection.

16. Define boundary layer thickness.

The thickness of the boundary layer has been defined as the distance from the surface at which the local velocity or temperature reaches 99% of the external velocity or temperature.

17. Indicate the concept or significance of boundary layer

In the boundary layer concept the flow field over a body is divided into two regions;

1. A thin region near the body called the boundary layer where the velocity and the temperature gradients are large

2. The region outside the boundary layer where the velocity and the temperature gradients are very nearly equal to their free stream values

18. Define momentum thickness.

The momentum thickness is defined as the distance through which the total loss of momentum per second be equal to if it were passing a stationary plate

19. Define displacement thickness

The displacement thickness is the distance measured perpendicular to the boundary by which the free stream is displaced on account of formation of boundary layer.

20. Define energy thickness.

The energy thickness can be defined as the distance, measured perpendicular to the boundary of the solid body, by which the boundary should be displaced to compensate for the reduction in the kinetic energy of the flowing fluid on account of boundary layer formation.

PART – B

1. Air at 200 kPa and 200°C is heated as it flows through a tube with a diameter of 25 mm at a velocity of 10 m./sec. The wall temperature is maintained constant and is 20°C above the air temperature all along the length of tube. Calculate:

(i) The rate of heat transfer per unit length of the tube

(ii) Increase in the bulk temperature of air over a 3 m length of the tube. (16)

2. Write down the momentum equation for a steady, two dimensional flow of an incompressible, constant property Newtonian fluid in the rectangular coordinate system and mention the physical significance of each term. (6)

A large vertical plate 5 m high is maintained at 100°C and exposed to air at 30°C. Calculate the convection heat transfer coefficient. (10)

3. Sketch the boundary layer development of a flow over a flat plate and explain the significance of the boundary layer. (6)

(ii) Atmospheric air at 275 K and a free stream velocity of 20 m/s flows over a flat plate 1.5 m long that is maintained at a uniform temperature of 325 K. Calculate the average heat transfer coefficient over the region where the boundary layer is laminar, the average heat transfer coefficient over the entire length of the plate and the total heat transfer rate from the plate to the air over the length 1.5 m and width 1 m. Assume transition occurs at Re = $2xl0^5$ (10)

4. What is Reynold's analogy? Describe the relation between fluid friction an heat transfer? (4)

(ii) Air at 25°C flows over 1 m x 3 m (3 m long) horizontal plate maintained at 200°C at 10 m/s. Calculate the average heat transfer coefficients for both laminar and turbulent regions. Take Re (critical) = 3.5×10^5 (12)

5. Define Reynold's, Nusselt and Prandtl numbers. (6)

A steam pipe 10 cm outside diameter runs horizontally in a room at 23°C. Take the outside surface temperature of pipe as 165°C. Determine the heat loss per unit length of the pipe. (10)

6. Explain for fluid flow along a flat plate:

(i) Velocity distribution in hydrodynamic boundary layer

(ii) Temperature distribution in thermal boundary layer

(iii) Variation of local heat transfer co-efficient along the flow. (8)

7. The water is heated in a tank by dipping a plate of 20 cm X 40 cm in size. The temperature of the plate surface is maintained at 100°C. Assuming the temperature of the surrounding water is at 30° C, Find the heat loss from the plate 20 cm side is in vertical plane.

8. Distinguish between free and forced convection giving examples. (4)

A steam pipe 10 cm OD runs horizontally in a room at 23° C. Take outside temperature of pipe as 165 ° C. Determine the heat loss per

unit length of the pipe. Pipe surface temperature reduces to 80° C with 1.5 cm insulation. What is the reduction in heat loss? (12)

9. Air at 400 K and 1 atm pressure flows at a speed of 1.5 m/s over a flat plate of 2 m long.
The plate is maintained at a uniform temperature of 300 K. If the plate has a width of 0.5 m, estimate the heat transfer coefficient and the rate of heat transfer from the air stream to the plate. Also estimate the drag force acting on the plate. (16)

10. Cylindrical cans of 150 mm length and 65 mm diameter are to be cooled from an initial temperature of 20°C by placing them in a cooler containing air at a temperature of 1°C and a pressure of 1 bar. Determine the cooling rates when the cans are kept in horizontal and vertical positions. (16)

11. A circular disc heater 0.2m in diameter is exposed to ambient air at 25°C. One surface of the disc is insulated at 130°C. Calculate the amount of heat transferred from the disc when it is.
(i) Horizontal with hot surface facing up (5)
(ii) Horizontal with hot surface facing down (5) (iii) Vertical (6)

UNIT III PHASE OF HEAT TRANSFER AND HEAT EXCHANGER

PART A

1. **What is meant by boiling and condensation? (Nov/Dec-2012)**
   The change of phase from liquid to vapour state is known as boiling.
   The change of phase from vapour to liquid state is known as condensation.

2. **What is meant by pool boiling? (Nov/Dec-2012)**
   If heat is added to a liquid from a submerged solid surface, the boiling process referred to as pool boiling. In this case the liquid above the hot surface is essentially stagnant and its motion near the surface is due to free convection and mixing induced by bubble growth and detachment.

3. **What is meant by LMTD? (April/May-2012)**
   We know that the temperature difference between the hot and cold fluids in the heat exchanger varies from point in addition various modes of heat transfer are involved.

Therefore based on concept of appropriate mean temperature difference, also called logarithmic mean temperature difference, also called logarithmic mean temperature difference, the total heat transfer rate in the heat exchanger is expressed as

Q = U A (T)m Where U – Overall heat transfer coefficient W/m^2K

4. Write about the applications of boiling and condensation. (April/May-2012)

Boiling and condensation process finds wide applications as mentioned below.

i) Thermal and nuclear power plant.
ii) Refrigerating systems
iii) Process of heating and cooling iv) Air conditioning systems

5. What are the various types of heat exchangers?(April/May-2011)

The types of heat exchangers are as follows i) Direct contact heat exchangers
ii) Indirect contact heat exchangers iii) Surface heat exchangers
iv) Parallel flow heat exchangers v) Counter flow heat exchangers
vi) Cross flow heat exchangers
vii) Shell and tube heat exchangers
viii) Compact heat exchangers.

6. Write about the merits of drop wise condensation. (Nov/Dec-2010)

In drop wise condensation, a large portion of the area of the plate is directly exposed to vapour. The heat transfer rate in drop wise condensation is 10 times higher than in film condensation.

7. What is meant by film wise and drop wise condensation? (April/May-2010)

The liquid condensate wets the solid surface, spreads out and forms a continuous film over the entire surface is known as film wise condensation.

In drop wise condensation the vapour condenses into small liquid droplets of various sizes
which fall down the surface in a random fashion.

8. What is meant by effectiveness? (April/May-2010)

The heat exchanger effectiveness is defined as the ratio of actual heat transfer to the maximum possible heat transfer.

Effectiveness $= \frac{\text{Actual heat transfer}}{\text{Maximum possible heat transfer}}$

9.Define – Heat exchanger (April/May-2009)

A heat exchanger is defined as equipment which transfers the heat from a hot fluid to a cold fluid.

10. What is meant by fouling factor? (April/May-2009)

We know the surfaces of heat exchangers do not remain clean after it has been in use for some time. The surfaces become fouled with scaling or deposits. The effect of these deposits the value of overall heat transfer coefficient. This effect is taken care of by introducing an additional thermal resistance called the fouling resistance.

11. What is meant by film wise condensation?

The liquid condensate wets the solid surface, spreads out and forms a continuous film over the entire surface is known as film wise condensation.

12 . What is meant by dropwise condensation?

In drop wise condensation the vapour condenses into small liquid droplets of various sizes which fall down the surface in a random fashion.

13. What is meant by indirect contact heat exchanger?

In this type of heat exchanger the transfer of heat between two fluids could be carried out by transmission through a wall which separated the two fluids

14. What is meant by regenerators?

In this type of heat exchangers, hot and cold fluids flow alternatively through the same space. e.g; ic engines, gas turbines

15. What is meant by receptors or surface heat exchangers?

This is most common type of heat exchanger in which the hot and cold fluid do not come into direct contact with each other but are separated by a tube wall or a surface e.g; Automobile radiators , air preheaters , economizers,etc.

16. What is meant by parallel flow heat exchanger?
In this type of heat exchanger, hot and cold fluids move in same direction

17. What is meant by counter flow heat exchanger?
In this type of heat exchanger, hot and cold fluids move in parallel but opposite direction

18. What is meant by cross flow heat exchanger?
In this type of heat exchanger, hot and cold fluids move at right angles to each other

19. What is meant by direct heat exchanger or open heat exchanger?
In direct contact heat exchanger, the heat exchange takes place by direct mixing of hot and cold fluids

20. What is meant by compact heat exchanger?
There are many special purpose heat exchangers called compact heat exchangers. they are generally employed when convective heat transfer coefficient associated with one of the fluids is much smaller than that associated with other fluid.

PART B

1. A tube of 2 m length and 25 mm outer diameter is to be used to condense saturated steam at 100°C while the tube surface is maintained at 92°C. Estimate the average heat transfer coefficient and the rate of condensation of steam if the tube is kept horizontal. The steam condenses on the outside of the tube. (16)

2. Steam condenses at atmospheric pressure on the external surface of the tubes of a steam condenser. The tubes are 12 in number and each is 30 mm in diameter and 10 m long. The inlet and outlet temperatures of cooling water flowing inside the tubes are 25°C and 60°C respectively. If the flow rate is 1.1 kg/s, calculate
(i) The rate of condensation of steam
(ii) The number of transfer units
(iii) The effectiveness of the condenser. (16)

3. It is desired to boil water at atmospheric pressure on a copper surface which electrically heated. Estimate the heat flux from the

surface to the water, if the surface is maintained at 10°c and also the peak heat flux. (8)
A tube of 2 m length and 25 mm OD is to be used to condense saturated steam at 100°C while the tube surface is maintained at 92°C. Estimate the average heat transfer coefficient and the rate of condensation of steam if the tube is kept horizontal. The steam condenses on the outside of the tube.

4. Give the classification of heat exchangers. (4)
It is desired to use a double pipe counter flow heat exchanger to cool 3 kg/s of oil (Cp = 2.1 kJ/kgK) from 120°C. Cooling water at 20°C enters the heat exchanger at a rate of 10 kg/so The overall heat transfer coefficient of the heat exchanger is 600 W/m2Kand the heat transfer area is 6 m2.Calculate the exit temperatures of oil and water. (12)

5. Discuss the general arrangement of parallel flow, counter flow and cross flow heat exchangers.

6. In a Double pipe counter flow heat exchanger 10000 kg/h of an oil having a specific heat of 2095 J/kgK is cooled from 80°C to 50°C by 8000 kg/h of water entering at 25°C. Determine the heat exchanger area for an overall heat transfer coefficient of 300 W/m2K. Take Cp for water as 4180 J/kgK (10)

7. Discuss the various regimes of pool boiling heat transfer. (8)
Dry saturated steam at a pressure of 2.45 bar condenses on the surface of a vertical tube of height 1 m. The tube surface temperature is kept at 117°C. Estimate the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.2m from the upper end of the tube. (8)

8. With a neat and labeled sketch explain the various regimes in boiling heat transfer. (8)
A vertical plate 0.5 m2 in area at temperature of 92°C is exposed to steam at atmospheric pressure. If the steam is dry and saturated estimate the heat transfer rate and condensate mass per hour. The vertical length of the plate is 0.5 m. Properties of water at film temperatures of
96°C can be obtained from tables. (8)

9. Compare LMTD and NTU method of heat exchanger analysis. (6)

Hot exhaust gases which enters a finned tube cross flow heat exchanger at 300°C and leave at 100°c, are used to heat pressurized water at a flow rate of 1 kg/s from 35 to 125°C. The exhaust gas specific heat is approximately 1000 J/kg.K, and the overall heat transfer co-efficient based on the gas side surface area is Uh = 100W/m2K. Determine the required gas side surface area Ah using the NTU method. Take Cp,c at Tc = 80°C is 4197 J/kg.K and Cp,h = 1000 J/kg.K . (10)

10. Water is to be boiled at atmospheric pressure in a mechanically polished stainless steel pan placed on top of a heating unit. The inner surface of the bottom of the pan is maintained at IO8°C. The diameter of the bottom of the pan is 30 cm. Assuming Csf = 0.0130. Calculate (i) the rate of heat transfer to the water and ii) the rate of evaporation of water. (16)

11. Define effectiveness of a heat exchanger. Derive an expression for the effectiveness of a double pipe parallel flow heat exchanger. State the assumptions made. (16)

12. Water enters a cross flow Heat exchanger (both fluids unmixed) at 5°C and flows at the rate of 4600 kg/h to cool 4000 kg/h of air that is initially at 40°C. Assume the overall heat transfer coefficient value to be 150 W/m2K For an exchanger surface area of 25m^2. Calculate the exit temperature of air and water. (16)

13. Describe the principle of parallel flow and counter flow heat exchangers showing the axial temperature distribution. (8)
A parallel flow heat exchanger has hot and cold water stream running through it, the flow rates are 10 and 25 kg/min respectively. Inlet temperatures are 75° C and 25° C on hot and cold sides. The exit temperature on the hot side should not exceed 50° C. Assume hi = ho = 600W/m2K. Calculate the area of heat exchanger using E -NTU approach. (8)

UNIT IV RADIATION

Part A

1. Define emissive power [E] and monochromatic emissive power. [E_b]

The emissive power is defined as the total amount of radiation emitted by a body per unit time and unit area. It is expressed in W/m^2. The energy emitted by the surface at a given length per unit time per unit area in all directions is known as monochromatic emissive power.

2. What is meant by absorptivity, reflectivity and transmissivity?

Absorptivity is defined as the ratio between radiation absorbed and incident radiation. Reflectivity is defined as the ratio of radiation reflected to the incident radiation. Transmissivity is defined as the ratio of radiation transmitted to the incident radiation.

3. What is black body and gray body?

Black body is an ideal surface having the following properties.

A black body absorbs all incident radiation, regardless of wave length and direction. For a prescribed temperature and wave length, no surface can emit more energy than black body.

If a body absorbs a definite percentage of incident radiation irrespective of their wave length, the body is known as gray body. The emissive power of a gray body is always less than that of the black body.

4. State Planck's distribution law.

The relationship between the monochromatic emissive power of a black body and wave

length of a radiation at a particular temperature is given by the following expression, by Planck.

Where Eb = Monochromatic emissive power W/m2

= Wave length – m

c1 = 0.374 10-15 W m2

c2 = 14.4 10-3 mK

5. State Wien's displacement law.

The Wien's law gives the relationship between temperature and wave length

corresponding to the maximum spectral emissive power of the black body at that temperature.

6. State Stefan – Boltzmann law.

The emissive power of a black body is proportional to the fourth power of absolute temperature.

7. Define Emissivity.

It is defined as the ability of the surface of a body to radiate heat. It is also defined as the ratio of emissive power of any body to the emissive power of a black body of equal temperature.

8. State Kirchoff's law of radiation.

This law states that the ratio of total emissive power to the absorbtivity is constant for all surfaces which are in thermal equilibrium with the surroundings.

It also states that the emissivity of the body is always equal to its absorptivity when the body remains in thermal equilibrium with its surroundings.

9. Define intensity of radiation (I_b)

It is defined as the rate of energy leaving a space in a given direction per unit solid angle

per unit area of the emitting surface normal to the mean direction in space.

10. State Lambert's cosine law.

It states that the total emissive power E_b from a radiating plane surface in any direction proportional to the cosine of the angle of emission

11. What is the purpose of radiation shield?

Radiation shields constructed from low emissivity (high reflective) materials. It is used to reduce the net radiation transfer between two surfaces.

12. Define irradiation (G) and radiosity (J)

It is defined as the total radiation incident upon a surface per unit time per unit area. It is expressed in W/m^2.

It is used to indicate the total radiation leaving a surface per unit time per unit area. It is expressed in W/m^2.

13. What is meant by shape factor?

The shape factor is defined as the fraction of the radiative energy that is diffused from on surface element and strikes the other surface directly with no intervening reflections. It is represented by F_{ij}. Other names for radiation shape factor are view factor, angle factor and configuration factor.

14. State lamberts cosine law.

It states that the total emmisive power Eb from a radiating plane surface in any direction propotional to the cosine of angle of emission

$$Eb \alpha \cos \emptyset$$

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Radiation shields constructed from low emissivity (high reflective) materials. It is used to reduce the net radiation transfer between two surfaces.

16. Define irradiation.

It is defined as the total radiation incident upon a surface per unit time per unit area. It is expressed in W/m^2

17.What is radiosity?

It is used to indicate the total radiation leaving a surface per unit time per unit area. It is expressed in W/m^2

18.. What are assumptions made to calculate radiation exchange exchange between the surfaces?

1. All surfaces are considered to be either black or gray
2. Radiation and reflection process are assumed to be diffuse.
3. The absorptive of a surface is taken equal to its emissivity and independent of temperature of source of the incident radiation

19. What is meant by shape factor and mention its physical significance?

The shape factor is defined as ‘’the fraction of the radiative energy that is diffused from one surface element and strikes the other surface directly with no intervening reflections ‘’. It is represented by Fij. Other names for radiation shape factor are view factor, angle factor and configuration factor. The shape factor is used in the analysis of radiating heat exchange between two surfaces

20.When the heat is transferred from hot body to cold body in a straight line without affecting the intervening medium it is referred to as heat transfer by

Ans; Radiation

PART B

1. Liquid Helium at 4.2 K is stored in a dewar flask of inner diameter = 0.48 m and outer diameter = 0.5 m. The Dewar flask can be treated as a spherical vessel. The outer surface of the inner vessel and the inner surface of the outer vessel are well polished and the emissivity of these surfaces is 0.05. The space between the two vessels is thoroughly evacuated. The inner surface of the dewar flask is at 4.2 K while the outer surface is at 300 K. Estimate the rate of heat transfer between the surfaces. (16)

2. A thin aluminium sheet with an emissivity of 0.1 on both sides is placed between two very large parallel plates that are maintained at uniform temperatures Tl = 800 K and T2 = 500 K and have emissivities £"1 = 0.2 and £"2 = 0.7 respectively. Determine the net rate of radiation heat transfer between the two plates per unit surface area of the plates and compare the result to that without shield. (16)

3. Discuss how the radiation from gases differs from that of solids. (6)
Two very large parallel plates with emissivities 0.5 exchange heat. Determine the percentage reduction in the heat transfer rate if a polished aluminium radiation shield of c = 0.04 is placed in between the plates. (10)

4. Define emissivity, absorptivity and reflectivity (06)
Describe the phenomenon of radiation from real surfaces. (10)

5. What are the radiation view factors and why they are used? (04)
Determine the view factor (F1-4) for the figure shown below. (12)

6. State and prove the following laws: (1) Kirchhoff's law of radiation (2) Stefan - Boltzmann law
(8)
Show-from energy-balance consideration that the radiation heat transfer from a plane composite surface area A4 and made up of plane surface areas A2 and A3 to a plane surface area Al is given by: A4F41=A3F31+A2F21 & F14=F12+F13 (8)

7. Explain briefly the following: (i) Specular and diffuse reflection (5) Reflectivity and transmissivity (5) Reciprocity rule and summation rule (6)

8. Two parallel, infinite grey surface are maintained at temperature of 127°C and 227°C respectively. If the temperature of the hot surface is increased to 327°C, by what factor is the net radiation exchange per unit area increased? Assume the emissivity's of cold and hot surface to be 0.9 and 0.7 respectively. (8)

Two equal and parallel discs of diameter 25 cm are separated by a distance of 50 cm. If the discs are maintained at 600°C and 250°C. Calculate the radiation heat exchange between them. (8)

9. Two large parallel planes with emissivity's 0.35 and 0.85 exchange heat by radiation. The planes are respectively 1073K and 773K. A radiation shield having the emissivity of 0.04 is placed between them. Find the percentage reduction in radiation heat exchange and temperature of the shield. (16)

UNIT V MASS TRANSFER

PART A

1. What is mass transfer?

The process of transfer of mass as a result of the species concentration difference in a mixture is known as mass transfer.

2. Give the examples of mass transfer.

Some examples of mass transfer.

1. Humidification of air in cooling tower
2. Evaporation of petrol in the carburetor of an IC engine.
3. The transfer of water vapour into dry air.

3. What are the modes of mass transfer?

There are basically two modes of mass transfer,

1. Diffusion mass transfer
2. Convective mass transfer

4. What is molecular diffusion?

The transport of water on a microscopic level as a result of diffusion from a region of higher concentration to a region of lower concentration in a mixture of liquids or gases is known as molecular diffusion.

5. What is Eddy diffusion?

When one of the diffusion fluids is in turbulent motion, eddy diffusion takes place.

6. What is convective mass transfer?

Convective mass transfer is a process of mass transfer that will occur between surface and a fluid medium when they are at different concentration.

7. State Fick's law of diffusion.

The diffusion rate is given by the Fick's law, which states that molar flux of an element per unit area is directly proportional to concentration gradient.

8. What is free convective mass transfer?

If the fluid motion is produced due to change in density resulting from concentration gradients, the mode of mass transfer is said to be free or natural convective mass transfer. Example : Evaporation of alcohol.

9. Define forced convective mass transfer.

If the fluid motion is artificially created by means of an external force like a blower or fan, that type of mass transfer is known as convective mass transfer.

Example: The evaluation if water from an ocean when air blows over it.

10. Define Schmidt Number.

It is defined as the ratio of the molecular diffusivity of momentum to the molecular diffusivity of mass.

Sc = Molecular diffusivity of momentum Molecular diffusivity of mass

11. Define Sherwood Number.

It is defined as the ratio of concentration gradients at the boundary.

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PART B

1. A steel sphere of radius 60 mm which is initially at a uniform temperature of 325°C is suddenly exposed to an environment at 25°C; with convection heat transfer coefficient 500 W/m2K. Calculate the temperature at a radius 36 mm and the heat transferred 100 seconds after the sphere is exposed to the environment. (16)

2. The tire tube of a vehicle has a surface area 0.62 m2 and wall thickness 12 mm. The tube has air filled in it at a pressure 2.4 x 105 N/m2. The air pressure drops to 2.3 x 105 N/m2 in 10 days. The volume of air in the tube is 0.034 m3. Calculate the diffusion coefficient of air in rubber at the temperature of 315K. Gas constant value = 287. Solubility of air in rubber tube = 0.075m3 of air/m3 of rubber tube at one atmosphere (16)

3. Define mass concentration, molar concentration, mass fraction and mole fraction.(4)
The diffusivity of CCl4 in air is determined by observing the steady state evaporation of CCl4 in a tube of 1 cm diameter exposed to air. The CCl4 liquid level is 10 cm below the top level of the tube. The system is held at 25°C and 1 bar pressure. The saturation pressure of CCl4 at
25°C is 14.76 kPa. If it is observed that the rate of evaporation of CCl4 is 0.1 kg/hour determine the diffusivity of CC14 into air. (12)

4. Dry air at 20°C (p = 1.2 kg/m3, v = 15 x lQ-6 m2/s, D = 4.2 x lQ-5 m2/s) flows over a flat plate of length 50 cm which is covered with a thin layer of water at a velocity of 1 m/s. Estimate the local mass transfer coefficient at a distance of 10 cm from the leading edge and the average mass transfer coefficient. (8)

5. A mixture of 0_2 and N_2 with their partial pressures in the ratio 0.21 to 0.79 is in a container at
25°C. Calculate the molar concentration, the mass density, the mole fraction and the mass fraction of each species for a total pressure of 1 bar. What would be the average molecular weight of the mixture? (8)

6. Explain Fick's first and second laws of diffusion.

7. Discuss the analogy between heat and mass transfer.

8. Explain the phenomenon of equimolar counter diffusion. Derive an expression for equimolar counter diffusion between two gases or liquids.

ME6503 - DESIGN OF MACHINE ELEMENTS

ME6503 DESIGN OF MACHINE ELEMENTS SYLLABUS REGULATION 2013

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT II SHAFTS AND COUPLINGS

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

UNIT III TEMPORARY AND PERMANENT JOINTS

Threaded fastners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

UNIT IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT V BEARINGS

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.

Text Book(s):

T1. Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2010.

T2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.

Reference Book(s):

R1. Sundararajamoorthy T. V. Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
R2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005
R3. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010
R4. Bernard Hamrock, Steven Schmid,Bo Jacobson, "Fundamentals of Machine Elements",2nd Edition, Tata McGraw-Hill Book Co., 2006.
R5. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
R6. Ansel Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
R7. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.

Course Outcomes:

CO1	Determine stresses in machine members for various load combinations and also machine members subjected to variable stresses.
CO2	Solve problems in hollow and solid shafts based on strength and rigidity and also involving rigid and flexible couplings.
CO3	Solve problems in temporary and permanent joints for both non eccentric loading and eccentric loading conditions.
CO4	Solve problems involving energy storing elements like springs and flywheels.
CO5	Solve problems involving engine Components like connecting rod and crank shafts
CO6	Solve problems involving sliding contact bearings and rolling contact bearings

CO Nos.		Level of correlation* of the COs with the relevant POs/PSOs						
	PO 1	PO 2	PO 3	PO 4	PO 6	PO 8	PSO1	PSO2
CO 1	3	2	1	-	-	-	3	-
CO 2	3	2	1	-	-	-	3	-
CO 3	3	2	1	-	-	-	3	-
CO 4	3	2	1	-	-	-	3	-
CO 5	3	2	1	-	-	-	3	-
CO 6	3	2	1	-	-	-	3	-

PART-A

2 Marks Question with Answers

UNIT I (STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS)

1. Define: Factor of safety
   The ratio between maximum stresses to working stress is known as factor of safety.

2. Define endurance limit.

   Endurance limit is the maximum value of completely reversed stress that the standard specimen can sustain an infinite number (10^6) of cycles without failure.

3. What is impact load?
   If the time of load application is less than one third of the lowest natural period of vibration of the part, it is called an impact load.

4. What are the various phases of design process?

i. Recognition of need.
ii. Definition of problem
iii. Synthesis
iv. Analysis and optimization
v. Evaluation
vi. Presentation

5. What are the different types of loads that can act on machine components?

a. Steady load.
b. Variable load.
c. Shock load
d. Impact load.

6. What are the factors affecting endurance strength.

Factors affecting endurance strength are

- Load
- Surface finish
- Size
- Temperature
- Impact
- Reliability

7. What are the types of variable stresses?

a. Completely reversed or cyclic stresses

b. Fluctuating stresses

c. Repeated stresses

8. Differentiate between repeated stress and reversed stress.

Repeated stress refers to a stress varying from zero to a maximum value of same nature.Reversed stress of cyclic stress varies from one value of tension to the same value of compression.

9. What are the types of fracture?

a. Ductile fracture

b. Brittle fracture

10. Distinguish between brittle fracture and ductile fracture.

In brittle fracture, crack growth is up to a small depth of the material. In ductile fracture large amount of plastic deformation is present to a higher depth.

11. Define stress concentration and stress concentration factor.

Stress concentration is the increase in local stresses at points of rapid change in cross section or discontinuities.

Stress concentration factor is the ratio of maximum stress at critical section to the nominal stress

12. Explain size factor in endurance strength.

Size factor is used to consider the effect of the size on endurance strength. A large size object will have more defects compared to a small one. So, endurance strength is reduced. If *K* is the size factor,

Actual endurance strength = Theoretical endurance limit x *K*

13. Explain Griffith theory. (Or) State the condition for crack growth.

A crack can propagate if the energy release rate of crack is greater than crack resistance.

14. What are the modes of fracture?

a. Mode I (Opening mode) – Displacement is normal to crack surface.

b. Mode II (Sliding mode) – Displacement is in the plane of the plate.

c. Mode III (Tearing mode) – Out of plane shear.

15. What are the factors to be considered in the selection of materials for a machine element?

i. Required material properties
ii. Manufacturing ease
iii. Material availability
iv. Cost

16. What are various theories of failure?

i. Maximum principal stress theory.
ii. Maximum shear stress theory.
iii Maximum principal strain theory.

17 List out the factors involved in arriving at factor of safety

i. material properties
ii. nature of loads
iii. presence of localized stresses
iv. mode of failures

18. Give some methods of reducing stress concentration.

i. Avoiding sharp corners.
ii. Providing fillets.
iii. Use of multiple holes instead of single hole

iv. Undercutting the shoulder parts.

19. Explain notch sensitivity. State the relation between stress concentration factor, fatigue stress concentration factor and notch sensitivity.
Notch sensitivity (q) is the degree to which the theoretical effect of stress concentration is actually reached. The relation is, $K_f = 1 + q (K_t-1)$

20. What are the factors that effect notch sensitivity?
i. Material
ii. Notch radius
iii. Size of component
iv. Type of loading
v. Grain Structure

21. What is the use of Goodman & Soderberg diagrams?
They are used to solve the problems of variable stresses.

22 Define machinability
It is the property of the material, which refers to a relative case with which a material can be cut. It is measured in a number of ways such as comparing the tool life for cutting different material

23. What is an S-N Curve?
An S- N curve has fatigue stress on Y axis and number of loading cycles in *X* axis. It is used to find the fatigue stress value corresponding to a given number of cycles.

24. Define Ductility
It is the property of the material enabling it to be drawn into wire, with the application of tensile force. It must be both strong and plastic. It is usually measured in terms of percentage elongation and reduction in area. (eg) Ni, Al, Cu

25. Define fatigue
When a material is subjected to repeated stress, it fails at stresses below the yield point stress; such type of failure of the material is called fatigue.

26. What is curved beam?

In curved beam the neutral axis does not coincide with the centroidal axis.

27. Give some example for curved beam.

C frame, crane hook

28. What is principle stress and principle plane?

A plane which has no shear stress is called principle plane the corresponding stress is called principle stress.

29. Write the bending equation.

M/I = E/R = Fs/Y.

M – Bending moment
I - Moment of intertia
E - Youngs modulus
R - Radius of the shaft
Fs – Shear stress
Y - Distance from neutral axis

30. Write the torsion equation.

T/J = CØ/L = Fs/R T – Torque
J - Polar moment of intertia
C- Rigidity modulus
Ø – Angle of twist
L – Length of the shaft
Fs – Shear stress
R - Radius of the shaft

UNIT II
(SHAFTS AND COUPLINGS)

1. Define the term critical speed.

The speed, at which the shaft runs so that the additional deflection of the shaft from the axis of rotation becomes infinite, is known as critical or whirling speed.

2. Factor is considered to design a shaft?

i. strength
ii. stiffness

3. What is key?

A key is device, which is used for connecting two machine parts for preventing relative motion of rotation with respect to each other.

4. What are the types of keys?
   i. Saddle key
   ii. Tangent key
   iii. Sunk key
   iv. Round key and taper pins

5. What is the main use of woodruff keys?
   A woodruff key is used to transmit small value of torque in automotive and machine tool industries. The keyway in the shaft is milled in a curved shape whereas the key way in the hub is usually straight.

6. List the various failures occurred in sunk keys.
   1. Shear failure
   2. Crushing failure
   3.

7. What is the function of a coupling between two shafts?
   Couplings are used to connect sections of long transmission shafts and to connect the shaft of a driving machine to the shaft of a driven machine.

8. Under what circumstances flexible couplings are used?
   They are used to join the abutting ends of shafts when they are not in exact alignment.
   They are used to permit an axial misalignment of the shafts without under absorption of the power, which the shafts are transmitting.

9. What are the purposes in machinery for which couplings are used?
1. To provide the connection of shafts of units those are manufactured separately such as motor and generator and to provide for disconnection for repairs or alterations.
2. To provide misalignment of the shafts or to introduce mechanical flexibility.
3. To reduce the transmission of shock from one shaft to another.
4. To introduce protection against over load.

10 What are the main functions of the knuckle joints?

It is used to transmit axial load from one machine element to other.

UNIT-3
(TEMPORARY AND PERMANENT JOINTS)

1 How is a bolt designated?

A bolt is designated by a letter M followed by nominal diameter and pitch in mm.

2. What factors influence the amount of initial tension?

i. External load ii. Material used iii. Bolt diameter

3. What is bolt of uniform strength?

A bolt of uniform strength has equal strength at the thread and shank portion.

4. What are the ways to produce bolts of uniform strength?

i. Reducing shank diameter equal to root diameter.

ii. Drilling axial hole

5. What stresses act on screw fastenings?

i. Initial stresses due to screwing up

ii. Stresses due to external forces

iii. Combined stresses.

6. What are the different applications of screwed fasteners?

The different applications of screwed fasteners are

a. For readily connecting & disconnecting machine parts withou t damage

b. The parts can be rigidly connected

c. Used for transmitting power

7. What are the advantages of screwed fasteners?

The advantages of screwed fasteners are

a. They are highly reliable in operation

b. They are convenient to assemble & disassemble

c. A wide range of screws can be used for various operating conditions

d. They are relatively cheap to produce.

8. Define pitch.

Pitch is defined as the distance from appoint on one thread to the corresponding on the adjacent thread in the same axis plane.

9. Define lead.

Lead is defined as the distance, which a screw thread advances axially in one rotation of the nut.

10. What are the different types of metric thread?

1. BSW (British standard Whit worth)
2. BSE (British standard End

11. Define welding.

Welding can be defined as a process of joining two similar or dissimilar metals with or without application of pressure along with or without addition of filler material.

12. What are the types of welded joints?

i. Butt joint ii. Lap joint iii. T – joint
iv. Corner joint v. Edge joint.

13. What are the two types of stresses are induced in eccentric loading of loaded joint?

1. Direct shear stress.
2. Bending or torsional shear stress.

14 Define butt and lap joint

Butt joint: The joint is made by welding the ends or edges of two plates.

Lap joint: The two plates are overlapping each other for a certain distance. Then welded. Such welding is called fillet weld.

15 When will the edge preparation need?

If the two plates to be welded have more than 6mm thickness, the edge preparation should be carried out.

16 What are the two types of fillet weld?

i. Longitudinal or parallel fillet weld ii. Transverse fillet weld

17 State the two types of eccentric welded connections.

i. Welded connections subjected to moment in a plane of the weld.

ii. Welded connections subjected to moment in a plane normal to the plane of the weld.

18 What are the practical applications of welded joints?

It has employed in manufacturing of machine frames, automobile bodies, aircraft, and structural works.

UNIT-4
(ENERGY STORING ELEMENTS AND ENGINE COMPONENTS)

1. What is a spring?

A spring is an elastic member, which deflects, or distorts under the action of load and regains its original shape after the load is removed.

2. State any two functions of springs.

i. To measure forces in spring balance, meters and engine indicators.

ii. To store energy.

3. What are the various types of springs?

i. Helical springs
ii. Spiral springs
iii. Leaf springs
iv. Disc spring or Belleville springs

4. Classify the helical springs.

a. Close – coiled or tension helical spring.

b. Open –coiled or compression helical spring.

5. Define : Leaf springs

A leaf spring consists of flat bars of varying lengths clamped together and supported at both ends, thus acting as a simply supported beam.

6. Define : Belleville Springs

They are made in the form of a cone disc to carry a high compressive force. In order to improve their load carrying capacity, they may be stacked up together. The major stresses are tensile and compressive.

7. What is spring index (C)?

The ratio of mean or pitch diameter to the diameter of wire for the spring is called the spring index.

8. What is pitch?

The axial distance between adjacent coils in uncompressed state.

9. What is solid length?

The length of a spring under the maximum compression is called its solid length. It is the product of total number of coils and the diameter of wire.

$Ls = n_t \times d$

Where, n_t = total number of coils.

10. What are the requirements of spring while designing?

a. Spring must carry the service load without the stress exceeding the safe value.

b. The spring rate must be satisfactory for the given application.

11 What are the end conditions of spring?

a. Plain end.

b. Plain and ground end c. Squared end

d. Squared and ground end.

12. What is buckling of springs?

The helical compression spring behaves like a column and buckles at a comparative small load when the length of the spring is more than 4 times the mean coil diameter.

13. What is surge in springs?

The material is subjected to higher stresses, which may cause early fatigue failure. This effect is called as spring surge.

14. What is a laminated leaf spring?

In order to increase, the load carrying capacity, number of flat plates are placed and below the other.

15. What semi – elliptical leaf springs?

The spring consists of number of leaves, which are held together by U- clips. The long leaf fastened to the supported is called master leaf. Remaining leaves are called as graduated leaves.

16. What is nipping of laminated leaf spring?

Prestressing of leaf springs is obtained by a difference of radii of curvature known as nipping.

17. What are the various application of springs?

The springs are used in various applications, they are

a. Used to absorb energy or shocks (e.g. shock absorbers, buffers, e.t.c.)

b. To apply forces as in brakes clutches, spring-loaded valves, e.t.c. c. To measure forces as in spring balances and engine indicators

d. To store energy as in watches

18. Define free length.

Free length of the spring is the length of the spring when it is free or unloaded condition. It is equal to the solid length plus the maximum deflection or compression plus clash allowance.

L_f = solid length + Y_{max} + 0.15 Y_{max}

19. Define spring index.

Spring index (C) is defined as the ratio of the mean diameter of the coil to the diameter of the wire.

$$C = D/d$$

20. Define spring rate (stiffness).

The spring stiffness or spring constant is defined as the load required per unit deflection of the spring.

$$K = W/y$$

Where W-load

y-deflection

21. Define pitch.

Pitch of the spring is defined as the axial distance between the adjacent coils in uncompressed state. Mathematically

Pitch=free length n-1

22. What are the points to be taken into consideration while selecting the pitch of the spring?

The points taken into consideration of selecting the pitch of the springs are

a. The pitch of the coil should be such that if the spring is accidentally compressed the stress does not increase the yield point stress in torsion.

b. The spring should not be close up before the maximum service load is reached.

23. Define active turns.

Active turns of the spring are defined as the number of turns, which impart spring action while loaded. As load increases the no of active coils decreases.

24. Define inactive turns.

Inactive turns of the spring is defined as the number of turns which does not contribute to the spring action while loaded. As load increases number of inactive coils increases from 0.5 to 1 turn.

25. What are the different kinds of end connections for compression helical springs?

The different kinds of end connection for compression helical springs are a. Plain ends

b. Ground ends c. Squared ends

d. Ground & square ends

26. Write about the eccentric loading of springs?

If the load acting on the spring does not coincide with the axis of the spring, then spring is said to be have eccentric load. In eccentric loading the safe load of the spring decreases and the stiffness of the spring is also affected.

27. Explain about surge in springs?

When one end of the spring is resting on a rigid support and the other end is loaded suddenly, all the coils of spring does not deflect equally, because some time is required for the propagation of stress along the wire. Thus a wave of compression propagates to the fixed end from where it is reflected back to the deflected end this wave passes through the spring indefinitely. If the time interval between the load application and that of the wave to propagate are equal, then resonance will occur. This will result in very high stresses and cause failure. This phenomenon is called surge.

28. What are the methods used for eliminating surge in springs?

The methods used for eliminating surge are

a. By using dampers on the center coil so that the wave propagation dies out
b. By using springs having high natural frequency.

29. What are the disadvantages of using helical spring of non-circular wires?

a. The quality of the spring is not good
b. The shape of the wire does not remain constant while forming the helix. It reduces the energy absorbing capacity of the spring.
c. The stress distribution is not favorable as in circular wires. But this effect is negligible where loading is of static nature.

30 Why concentric springs are used?

a. To get greater spring force with in a given space
b. To insure the operation of a mechanism in the event of failure of one of the spring

31. What is the advantage of leaf spring over helical spring?

The advantage of leaf spring over helical spring is that the end of the spring may be guided along a definite path as it deflects to act a

structural member in addition to energy absorbing device.

32. Write notes on the master leaf & graduated leaf?

The longest leaf of the spring is known as main leaf or master leaf has its ends in the form of an eye through which bolts are passed to secure the spring.

The leaf of the spring other than master leaf is called the graduated leaves.

33. What is meant by nip in leaf springs?

By giving greater radius of curvature to the full length leaves than the graduated leaves, before the leaves are assembled to form a spring thus a gap or clearance will be left between the leaves. This initial gap is called nip.

34. What is the application of leaf spring?

The leaf springs are used in automobiles as shock absorbers for giving suspension to the automobile and it gives support to the structure.

35. Define flat spiral spring.

A flat spiral spring is a long thin strip of elastic material wound like a spiral. These springs are frequently used in watch springs, gramophones, e.t.c

36. What are the differences between helical torsion spring and tension helical springs?

Helical torsion springs are wound similar to that of tension springs but the ends are shaped to transmit torque. The primary stress in helical torsion spring is bending stress whereas in tension springs the stresses are torsional shear stresses.

37. Define helical springs.

The helical springs are made up of a wire coiled in the form of a helix and is primarily intended for compressive or tensile load.

38. What are the different types of helical springs?

The different types of helical springs are

a. Open coil helical spring
b Closed coil helical spring

39. What are the differences between closed coil & open coil helical springs?

Closed coil helical spring	Open coil helical spring
The spring wires are coiled very closely, each turn is nearly at right angles	The wires are coiled such that there is a gap between the two consecutive turns.
Helix angle is less than 10^{o}	Helix angle is large ($>10^{o}$)

UNIT - V
(BEARINGS)

1. What is bearing?
   Bearing is a stationery machine element which supports a rotating shafts or axles and confines its motion.

2. Classify the types of bearings.
   i. Depending upon the type of load coming upon the shaft:
      a. Radial bearing
      b. Thrust bearings.
   ii. Depending upon the nature of contact:
      a. Sliding contact
      b. Rolling contact bearings or Antifriction bearings.

3. What are the required properties of bearing materials?
   Bearing material should have the following properties. i. High compressive strength ii. Low coefficient of friction iii. High thermal conductivity iv. High resistance to corrosion v. Sufficient fatigue strength

vi. It should be soft with a low modulus of elasticity

vii. Bearing materials should not get weld easily to the journal material.

4. What is a journal bearing?

A journal bearing is a sliding contact bearing which gives lateral support to the rotating shaft.

5. What are the types of journal bearings depending upon the nature of contact?

1. Full journal bearing
2. Partial bearing
3. Fitted bearing.

6. What are the types of journal bearing depending upon the nature of lubrication?

1. Thick film type
2. Thin film type
3. Hydrostatic bearings
4. Hydrodynamic bearing.

7. What is known as self – acting bearing?

The pressure is created within the system due to rotation of the shaft, this type of bearing is known as self – acting bearing.

8. What is flywheel?

Flywheel is a machine elements used to minimize the fluctuation of speed in a engine.

9. What is the function of flywheel?

A flywheel used in machine serves as a reservoir which stores energy during the period when the supply of energy is more than the requirement and releases it dulling the period when the requirement of energy is more than the supply.

10. Define the term 'fluctuation of speed' and 'fluctuation of energy'.

The ratio of maximum fluctuation of speed to the mean speed is called co efficient of fluctuation of speed.

The ratio of fluctuation of energy to the mean energy is called coefficient of fluctuation of energy.

11. State the type of stresses induced in a rim flywheel?

1. Tensile stress due to centrifugal force

2. Tensile bending stress caused by the restraint of the arms and
3. The shrinkage stresses due to unequal rate of cooling of casting.

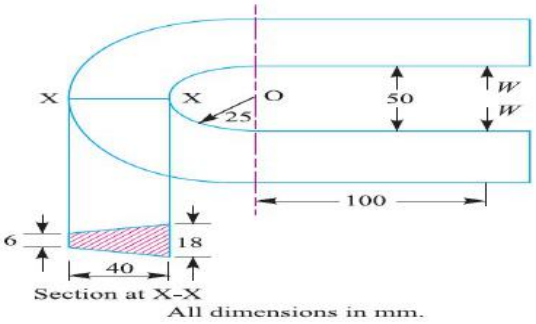
12. What are the stresses induced in flywheel arms?
1. Tensile stress due to centrifugal force.
2. Bending stress due to torque.
3. Stress due to belt tension.

13. How does the function of flywheel differ from that of governor?

A governor regulates the mean speed of an engine when there are variations in the mean loads. It automatically controls the supply of working fluid to engine with the varying load condition & keeps the mean speed with contain limits. It does not control the speed variation caused by the varying load. A flywheel does not maintain const speed.

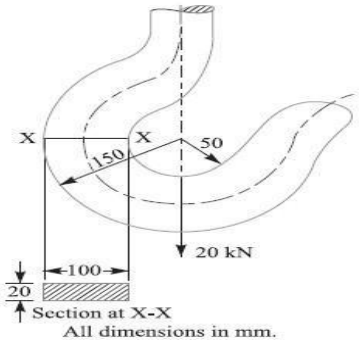
PART – B IMPORTANT QUESTIONS
Unit I (STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS)

1. The frame of a punch press is shown in Fig. 5.9. Find the stresses at the inner and outer surface at section X-X of the frame, if W = 5000 N.



2 The crank hook carries a load of 20 KN as shown in FIG.(2).This section at X- X is rectangular whose horizontal side is 100mm.

Find the stresses in the inner and outer fibers at the given section

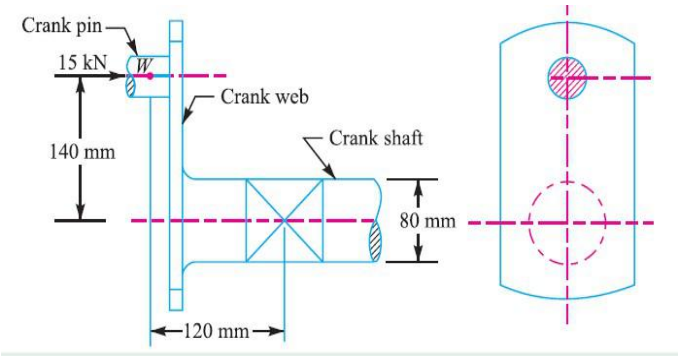


3. The load on a bolt consists of an axial pull of 10kN together with a transverse shear force of 5Kn. Find the diameter of bolt required according to

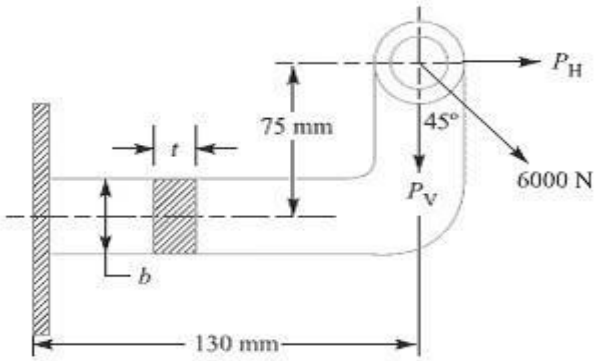
1. Maximum principal stress theory; 2. Maximum shear stress theory; 3. Maximum principal strain theory; 4. Maximum strain energy theory and 5. Maximum distortion energy theory.

4. A bar of circular cross section is subjected to alternating tensile forces varying from a minimum of 200KN to a maximum of 500KN. It is to be manufactured of material with an ultimate tensile strength of 900Mpa and an endurance limit of
700Mpa. Determine the diameter of bar using safety factors of 3.5 related to ultimate tensile strength and 4 related to endurance limit and stress concentration factor of 1.65 for a fatigue load. Use Goodman straight line as basis for design.

5. An overhang crank with pin and shaft is shown in Fig. 5.18. A tangential load of 15 kN acts on the crank pin. Determine the maximum principal stress and the maximum shear stress at the centre of the crankshaft bearing.



6. A mild steel bracket as shown in fig. (1) is subjected to a pull of 6000N acting at 45^0 to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60 MPa.

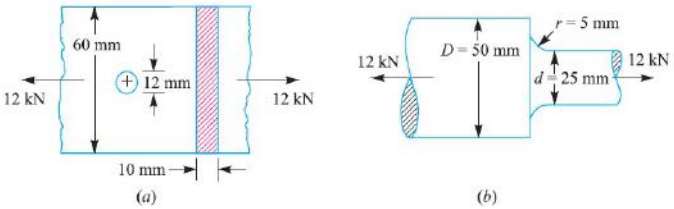


7. Find the maximum stress induced in the following cases taking stress concentration into account:

1. A rectangular plate 60 mm × 10 mm with a hole 12 diameter as shown in Fig. (a)

and subjected to a tensile load of 12 kN.

2. A stepped shaft as shown in Fig. (b) and carrying a tensile load of 12 kN.



8. A leaf spring in an automobile is subjected to cyclic stresses. The average stress = 150

MPa; variable stress = 500 MPa; ultimate stress = 630 MPa; yield point stress = 350

MPa and endurance limit = 150 MPa. Estimate, under what factor of safety the spring is working, by Goodman and Soderberg formulae.

9. A steel connecting rod is subjected to a completely reversed axial load of 160 kN.

Suggest the suitable diameter of the rod using a factor of safety 2. The ultimate tensile strength of the material is 1100 MPa, and yield strength 930 MPa. Neglect column action and the effect of stress concentration.

10. A pulley is keyed to a shaft midway between two anti-friction bearings. The bending moment at the pulley varies from – 170 N-m to 510 N-m and the torsional moment in the shaft varies from 55 N-m to 165 N-m. The frequency of the variation of the loads is the same as the shaft speed. The shaft is made of cold drawn steel having an ultimate strength of 540 MPa and a yield strength of 400 MPa. Determine the required diameter for an indefinite life. The stress concentration factor for the keyway in bending and torsion may be taken as 1.6 and 1.3 respectively. The factor of safety is 1.5. Take size factor = 0.85 and surface finish factor = 0.88.

UNIT-II (SHAFTS AND COUPLINGS)

1. A hollow steel shaft transmits 600 kW at 500 r.p.m. The maximum shear stress is 62.4MPa. Find the

outside and inside diameter of the shaft, if the outer diameter is twice of inside diameter, assuming that the maximum torque is 20% greater than the mean torque.

2. Two 400 mm diameter pulleys are keyed to a simply supported shaft 500 mm apart. Each pulley is 100 mm from its support and has horizontal belts, tension ratio being 2.5. If the shear stress is to be limited to 80 MPa while transmitting 45 kW at 900 r.p.m., find the shaft diameter if it is to be used for the input-output belts being on the same or opposite sides.

3. Fig. 14.17 shows a shaft from a hand-operated machine. The frictional torque in the journal bearings at *A* and *B* is 15 N-m each. Find the diameter (*d*) of the shaft (on which the pulley is mounted) using maximum distortion energy criterion. The shaft material is 40 C 8 steel for which the yield stress in tension is 380 MPa and the factor of safety is 1.5

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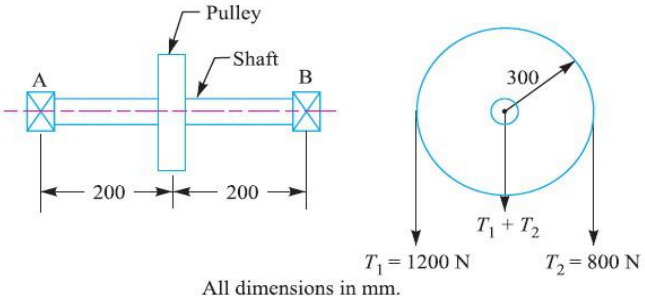
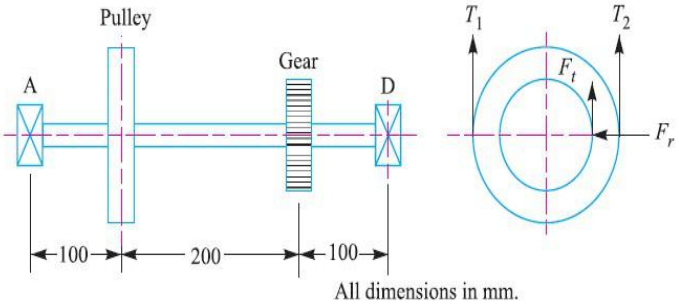


All dimensions in mm.

4. A shaft made of steel receives 7.5 kW power at 1500 r.p.m. A pulley mounted on the shaft as shown in Fig. 14.19 has ratio of belt tensions 4.
The gear forces are as follows: F_t = 1590 N; F_r = 580 N
Design the shaft diameter by maximum shear stress theory. The shaft material has the

following properties: Ultimate tensile strength = 720 MPa; Yield strength = 380 MPa; Factor of safety = 1.5.



5. The internal diameter of a hollow shaft is 2/3 rd of its external diameter. Compare the strength and stiffness of the shaft with that of a solid shaft of the same material.

6. The shaft of an axial flow rotary compressor is subjected to a maximum torque of 2000 N-m and a maximum bending moment of 4000 N-m. The combined shock and fatigue factor in torsion is 1.5 and that in bending is 2. Design the diameter of the shaft, if the shear stress in the shaft is 50 MPa. Design a hollow shaft for the above compressor taking the ratio of outer diameter to the inner diameter as 2. What is the percentage saving in material ? Also compare the stiffness.

7. A steel shaft has a diameter of 25 mm. The shaft rotates at a speed of 600 r.p.m. and transmits 30 kW through a gear. The tensile and yield strength of the material of shaft are 650 MPa and 353 MPa respectively. Taking a factor of safety 3, select a suitable key for the gear. Assume that the key and shaft are made of the same material.

8. Design a cast iron protective flange coupling to connect two shafts in order to transmit 7.5 kW at 720 r.p.m. The following permissible stresses may be used : Permissible shear stress for shaft, bolt and

key material = 33 MPa Permissible crushing stress for bolt and key material = 60 MPa Permissible shear stress for the cast iron = 15 MPa

9. Two shafts made of plain carbon steel are connected by a rigid protective type flange coupling. The shafts are running at 500 r.p.m. and transmit 25 kW power. Design the coupling completely for overload capacity 25 per cent in excess of mean transmitted torque capacity. Assume the following permissible stresses for the coupling components :

Shaft — Permissible tensile stress = 60 MPa; Permissible shear stress = 35 MPa

Keys — Rectangular formed end sunk key having permissible compressive strength = 60 MPa

Bolts — Six numbers made of steel having permissible shear stress = 28 MPa

Flanges — Cast iron having permissible shear stress = 12 MPa

Draw two views of the coupling you have designed.

10. A flanged protective type coupling is required to transmit 50 kW at 2000 r.p.m.. Find:

(a) Shaft diameters if the driving shaft is hollow with d_i / d_0 = 0.6 and driven shaft is a solid shaft. Take τ = 100 MPa.

(b) Diameter of bolts, if the coupling uses four bolts. Take $\sigma_c = \sigma_t$ = 70 MPa and τ= 25 MPa. Assume pitch circle diameter as about 3 times the outside diameter of the hollow shaft.

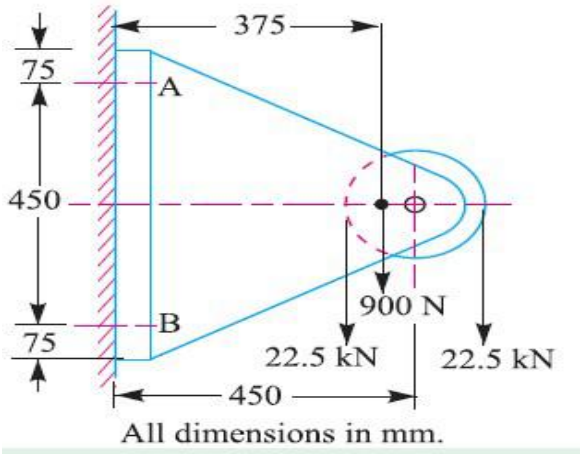
(*c*) Thickness of the flange and diameter of the hub. Assume σ_c = 100 MPa and τ= 125 MPa.

(*d*) Make a neat free hand sketch of the assembled coupling showing a longitudinal sectional elevation with the main dimensions. The other dimensions may be assumed suitably.

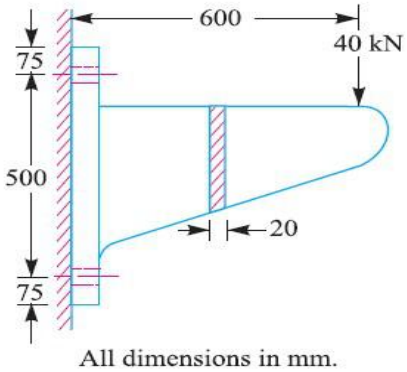
UNIT-III
(TEMPORARY AND PERMANENT JOINTS)

1. A pulley bracket, as shown in Fig. 11.49, is supported by 4 bolts, two at *A-A* and two at *B-B*.

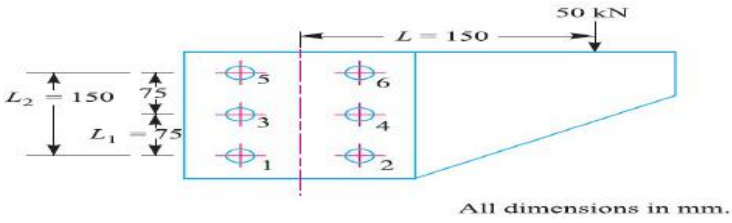
Determine the size of bolts using an allowable shear stress of 25 MPa for the material of the bolts.



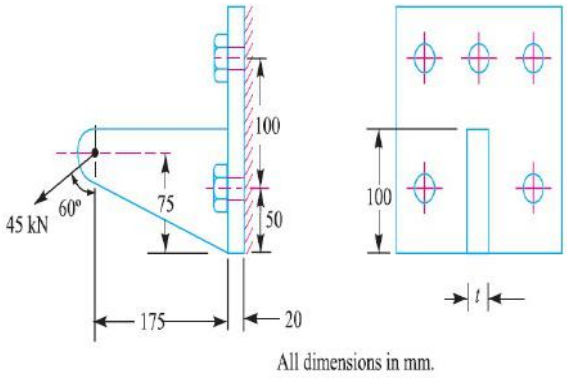
2. A wall bracket, as shown in Fig. 11.50, is fixed to a wall by means of four bolts. Find the size of the bolts and the width of bracket. The safe stress in tension for the bolt and bracket may be assumed as 70 MPa.



3. A bracket is bolted to a column by 6 bolts of equal size as shown in Fig. 11.51. It carries a load of 50 kN at a distance of 150 mm from the centre of column. If the maximum stress in the bolts is to be limited to 150 MPa, determine the diameter of bolt.



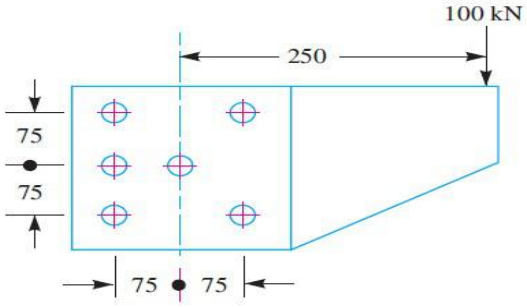
4. A bracket, as shown in Fig. 11.53, is fixed to a vertical steel column by means of five standard bolts. Determine : (*a*) The diameter of the fixing bolts, and (*b*) The thickness of the arm of the bracket. Assume safe working stresses of 70 MPa in tension and 50
MPa in shear.



5. Design a cotter joint to connect two mild steel rods for a pull of 30 kN. The maximum permissible stresses are 55 MPa in tension ; 40 MPa in shear and 70 MPa in crushing. Draw a neat sketch of the joint designed.

6. Design a knuckle joint to connect two mild steel bars under a tensile load of 25 kN. The allowable stresses are 65 MPa in tension, 50 MPa in shear and 83 MPa in crushing.

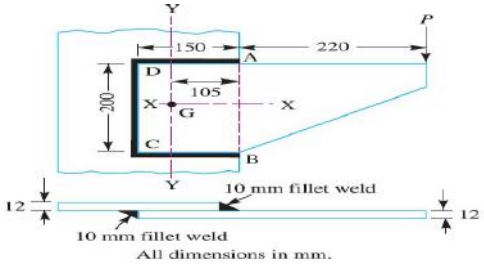
7. A bracket is riveted to a columm by 6 rivets of equal size as shown in Fig. 9.38. It carries a load of 100 kN at a distance of 250 mm from the column. If the maximum shear stress in the rivet is limited to 63 MPa, find the diameter of the rivet.



All dimensions in mm.

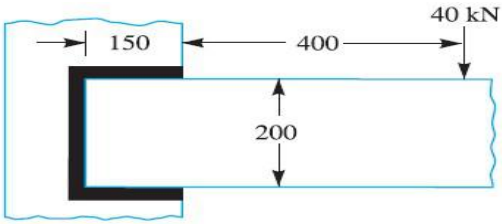
8. A triple riveted butt joint with equal double cover plates (zig-zag riveting) is used for the longitudinal joint of a Lancashire boiler of 2.5 m internal diameter. The working steam pressure is 1.12 N/mm2 and the efficiency of the joint is 85 per cent. Calculate the plate thickness for mild steel of 460 MPa ultimate tensile strength. Assume ratio of tensile to shear stresses as 7/6 and factor of safety 4. The resistance of the rivets in double shear is to be taken as 1.875 times that of single shear. Design a suitable circumferential joint also.

9. A bracket is welded to the side of a column and carries a vertical load *P*, as shown in Fig. 10.38. Evaluate *P* so that the maximum shear stress in the 10 mm fillet welds is 80 MPa.



All dimensions in mm.

10. A bracket, as shown in Fig. 10.39, carries a load of 40 kN. Calculate the size of weld, if the allowable shear stress is not to exceed 80 MPa.



All dimensions in mm.

UNIT-IV (ENERGY STORING ELEMENTS AND ENGINE COMPONENTS)

1. Design a compression helical spring to carry a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume the following values for the spring material:

Permissible shear stress = 350 MPa
Modulus of rigidity = 84 kN/mm^2

$$\text{Wahl's factor} = \frac{4C-1}{4C-4} + \frac{0.615}{C}, \text{ where } C = \text{spring in}$$

2. Design a helical spring for a spring loaded safety valve for the following conditions : Operating pressure = 1 N/mm2

Maximum pressure when the valve blows off freely = 1.075 N/mm^2

Maximum lift of the valve when the pressure is 1.075 N/mm^2 = 6 mm

Diameter of valve seat = 100 mm

Maximum shear stress = 400 MPa

Modulus of rigidity = 86 kN/mm^2

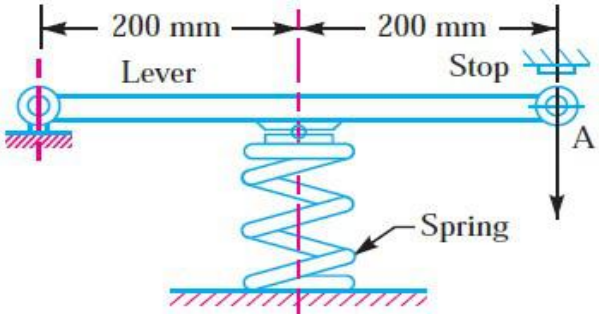
Spring index = 5.5

3. A vertical spring loaded valve is required for a compressed air receiver. The valve is to start opening at a pressure of 1 N/mm^2 gauge and must be fully open with a lift of 4 mm at a pressure of 1.2 N/mm^2 gauge. The diameter of the port is 25 mm.

assume the allowable shear stress in steel as 480 MPa and shear modulus as 80 kN/mm^2.

Design a suitable close coiled round section helical spring having squared ground ends. Also specify initial compression and free length of the spring.

4. A spring controlled lever is shown in Fig. 23.34. The spring is to be inserted with an initial compression to produce a force equal to 125 N between the right hand end of the lever and the stop. When the maximum force at *A* reaches to a value of 200 N, the end of the lever moves downward by 25 mm.



Assuming a spring index as 8, determine: 1. spring rate, 2 size of wire, 3. outside diameter of the spring, 4. number of active coils, and 5. free length, assuming squared and ground ends. The allowable shear stress may be taken as 420 MPa and *G* = 80 kN/mm^2.

5. A railway wagon weighing 50 kN and moving with a speed of 8 km per hour has to be stopped by four buffer springs in which the maximum compression allowed is 220 mm. Find the number of turns in each spring of mean diameter 150 mm. The diameter of spring wire is 25 mm. Take *G* = 84 kN/mm^2.

6. A semi-elliptical spring has ten leaves in all, with the two full length leaves extending

625 mm. It is 62.5 mm wide and 6.25 mm thick. Design a helical spring with mean diameter of coil 100 mm which will have approximately the same induced stress and deflection for any load. The Young's modulus for the material of the semi-elliptical spring may be taken as 200 kN/mm^2 and modulus of rigidity for the material of helical spring is 80 kN/mm^2.

7. Design a leaf spring for the following specifications : Total load = 140 kN ; Number of springs supporting the load = 4 ; Maximum number of leaves = 10; Span of the spring = 1000 mm ; Permissible deflection = 80 mm. Take Young's modulus, E = 200 kN/mm^2 and allowable stress in spring material as 600 MPa.

8. Design a cast iron flywheel for a four stroke cycle engine to develop 110 kW at 150 r.p.m. The work done in the power stroke is 1.3 times the average work done during the whole cycle. Take the mean diameter of the flywheel as 3 metres. The total fluctuation of speed is limited to 5 per cent of the mean speed. The material density is 7250 kg / m^3. The permissible shear stress for the shaft material is 40 MPa and flexural stress for the arms of the flywheel is 20 MPa.

9. A punching press is required to punch 40 mm diameter holes in a plate of 15 mm thickness at the rate of 30 holes per minute. It requires 6 N-m of energy per mm^2 of sheared area. Determine the moment of inertia of the flywheel if the punching takes one-tenth of a second and the r.p.m. of the flywheel varies from 160 to 140.

10. Design completely the flywheel, shaft and the key for securing the flywheel to the shaft, for a punching machine having a capacity of producing 30 holes of 20 mm diameter per minute in steel plate 16 mm thickness. The ultimate shear stress for the material of the plate is 360 MPa. The actual punching operation estimated to last for a period of 36º rotation of the punching machine

crankshaft. This crank shaft is powered by a flywheel shaft through a reduction gearing having a ratio 1 : 8. Assume that the mechanical efficiency of the punching machine is 80% and during the actual punching operation the flywheel speed is reduced by a maximum of 10%. The diameter of flywheel is restricted to 0.75 m due to space limitations.

UNIT-V (BEARINGS)

1. The ball bearings are to be selected for an application in which the radial load is 2000N during 90 per cent of the time and 8000 N during the remaining 10 per cent. The shaft is to rotate at 150 r.p.m. Determine the minimum value of the basic dynamic load rating for 5000 hours of operation with not more than 10 per cent failures.

2. A single row deep groove ball bearing operating at 2000 r.p.m. is acted by a 10 kN radial load and 8 kN thrust load. The bearing is subjected to a light shock load and the outer ring is rotating. Determine the rating life of the bearing.

3. A ball bearing subjected to a radial load of 4000 N is expected to have a satisfactory life of 12 000 hours at 720 r.p.m. with a reliability of 95%. Calculate the dynamic load carrying capacity of the bearing, so that it can be selected from manufacturer's catalogue based on 90% reliability. If there are four such bearings each with a reliability of 95% in a system, what is the reliability of the complete system?

4. A rolling contact bearing is subjected to the following work cycle : (*a*) Radial load of 6000 N at 150 r.p.m. for 25% of the time; (*b*) Radial load of 7500 N at 600 r.p.m. for 20% of the time; and (*c*) Radial load of 2000 N at 300 r.p.m. for 55% of the time. The inner ring rotates and loads are steady. Select a bearing for an expected average life of2500 hours.

5. A journal bearing is proposed for a steam engine. The load on the journal is 3 kN, diameter

50 mm, length 75 mm, speed 1600 r.p.m., diametral clearance 0.001 mm, ambient temperature 15.5°C. Oil SAE 10 is used and the film temperature is 60°C. Determine the heat generated and heat dissipated. Take absolute viscosity of SAE10 at 60°C = 0.014 kg/m-s.

6. A journal bearing is to be designed for a centrifugal pump for the following data : Load on the journal = 12 kN ; Diameter of the journal = 75 mm ; Speed = 1440 r.p.m ; Atmospheric temperature of the oil = 16°C ; Operating temperature of the oil = 60°C; Absolute viscosity of oil at 60°C = 0.023 kg/m-s. Give a systematic design of the bearing.

7. Design a journal bearing for a centrifugal pump running at 1440 r.p.m. The diameter of the journal is 100 mm and load on each bearing is 20 kN. The factor *ZN/p* may be taken as 28 for centrifugal pump bearings. The bearing is running at 75°C temperature and the atmosphere temperature is 30°C. The energy dissipation coefficient is 875 $W/m^2/°C$. Take diametral clearance as 0.1 mm.

8. A journal bearing with a diameter of 200 mm and length 150 mm carries a load of 20 kN, when the journal speed is 150 r.p.m. The diametral clearance ratio is 0.0015. If possible, the bearing is to operate at 35°C ambient temperature without external cooling with a maximum oil temperature of 90°C. If external cooling is required, it is to be as little as possible to minimise the required oil flow rate and heat exchanger size.
1. What type of oil do you recommend?
2. Will the bearing operate without external cooling?
3. If the bearing operates without external cooling, determine the operating oil temperature?
4. If the bearing operates with external cooling, determine the amount of oil in kg/min required to carry away the excess heat generated over heat dissipated, when the oil temperature rises from 85°C to 90°C, when passing through the bearing.

9. Determine the dimensions of an *I*-section connecting rod for a petrol engine from the following data: Diameter of the piston = 110 mm; Mass of the reciprocating parts = 2 kg; Length of the connecting rod from centre to centre = 325 mm; Stroke length = 150 mm; R.P.M. = 1500 with possible over speed of 2500; Compression ratio = 4: 1; Maximum explosion pressure = 2.5 N/mm^2.

10. A connecting rod is required to be designed for a high speed, four stroke I.C. engine.The following data are available. Diameter of piston = 88 mm; Mass of reciprocating parts = 1.6 kg; Length of connecting rod (centre to centre) = 300 mm; Stroke = 125 mm; R.P.M. = 2200 (when developing 50 kW); Possible over speed = 3000 r.p.m.; Compression ratio = 6.8: 1 (approximately); Probale maximum explosion pressure (assumed shortly after dead centre, say at about 3°) = 3.5 N/mm^2. Draw fully dimensioned drawings of the connecting rod showing the provision for the lubrication.

ME6504 METROLOGY AND MEASUREMENTS

ME6504 METROLOGY AND MEASUREMENTS SYLLABUS REGULATION 2013

UNIT I .BASICS OF METROLOGY

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

UNIT II LINEAR AND ANGULAR MEASUREMENTS

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III ADVANCES IN METROLOGY

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

UNIT IV FORM MEASUREMENT

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE

Force, torque, power - mechanical , Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

Text Book(s)

T 1: Jain R.K. “Engineering Metrology”, Khanna Publishers, 2005.

T 2: Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.

Reference Book(s)
R 1: Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA, 1990.
R 2: Backwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2006.

Course Outcomes:

CO1. Explain the concepts, elements, characteristics of metrology, errors in measurements and standards
CO2. Demonstrate various types of linear measuring instruments, interchangeability and selective assembly
CO3. Demonstrate the various types of angular measuring instruments
CO4. Explain the working of various types of laser instruments and its applications, CMM and machine vision.
CO5. Illustrate the different terms used in form measurements such as thread, gear, roundness and surface finish
CO6. Explain the working principle of physical parameters of flow, temperature, force, torque and power

CO Nos.		Level of correlation* of the COs with the relevant POs/PSOs						
	PO 1	PO 2	PO 3	PO 4	PO 6	PO 12	PSO 1	PSO2
CO 1	2	1	-	-	2	3	2	3
CO 2	2	1	-	-	2	3	2	3
CO 3	2	1	-	-	2	2	2	3
CO 4	2	1	-	-	2	2	2	3
CO 5	2	1	-	-	2	2	2	3
CO 6	2	1	-	-	2	3	2	3

ME6504 METROLOGY AND MEASUREMENTS
UNIT - 1 BASICS OF METROLOGY
PART -A QUESTIONS WITH ANSWERS

1. Define Metrology.

Ans: Metrology means Science of measurement. (or) System of measurement. (or) Science that deals with measurement.

Definition: Metrology is the establishment, reproduction, conservation and transfer of units of measurements and their standards.

2. Define Measurement. Give its types.

Ans: Measurement is a series of operations carried out by means of measuring instruments to determine the numerical value of the size which describes the object of the measurement.

Measurement is a process of comparing the input signal (unknown magnitude) with a pre-defined standard and giving out the result.

Its types are : Direct comparison method, Indirect comparison method, Primary measurement, Secondary measurement and Tertiary measurement.

3. What are the types of Metrology?

Ans: 1. Legal Metrology 2. Dynamic Metrology 3. Deterministic Metrology
4. Industrial Metrology 5. Scientific Metrology

4. What are the types of measurement?

Ans: Direct comparison method, Indirect comparison method, Primary measurement, Secondary measurement and Tertiary measurement.

5. What is Legal metrology?

Ans: Legal metrology is the metrology that deals with units of measurements, methods of measurements and the measuring instruments in relation to the statutory, technical and legal requirements.

Legal metrology is a part of metrology directed by a National Organisation called “National Service of Legal Metrology”. The main objective is to maintain the uniformity of measurement in a particular country.

6. State the applications of Legal Metrology.

Ans: 1. Industrial Measurement – eg: Pollution monitoring, environmental protection.
2. Commercial transactions – eg: To protect both buyer and seller in a commercial transaction.
3. Public health – eg: incorrect radiation dose in cancer treatment have a critical effect.
4. Human Safety – eg: road safety

7. Define Dynamic metrology.

Ans: Technique of measuring small variations of a continuous nature. This technique has proved very valuable and a record of continuous measurement over a surface. Ex: Electric meters, Taximeters, Flow meter, speedometers, measurement of force during a crash test, measurement of pressure in a automotive engine.

8. Define Deterministic metrology.

Ans: It is a new philosophy where part measurement is replaced by process measurement. Full advantage is taken of the deterministic nature of the automated machines. All manufacturing subsystems are optimised to maintain deterministic performance within acceptable quality levels. Measurements are in built as part of the process (in-situ) aimed at a defined output. New techniques such as CNC systems and expert systems are applied, leading to fully adaptive control. This technology is used for very high precision manufacturing machinery and control systems to achieve micro technology and Nanotechnology accuracies.

9. Define Industrial metrology.

Ans: It deals with measurements in production and quality control. It covers quality procedures, calibration intervals, control of measurement processes and management of measuring instruments in industry.

10. Define Scientific metrology.

Ans: It deals with problems common to all metrological questions. It covers problems of errors and uncertainity in measurement, problem of metrological properties of measuring instruments.

11. Mention the two important requirements of measurement.

Ans: i) The standards used for comparison must be accurate and internationally accepted. ii) The apparatus or instrument and the process used for comparison must be provable.

12. What are the basic components of a measuring system?

Ans: i) units ii) scale iii) target iv) limits v) tool vi) process

13. Name the fundamental measuring process in measurement.

Ans: i) Direct comparison ii) Indirect comparison

14. What are the applications of measurement?

Ans: i) Measurement provides the fundamental basis for research and development activities. ii) Measurement is a fundamental element of any automatic control system. iii) Measurement is used to evaluate the performance of any plant or a process iv) Measurement is also the basis for commercial activities such as production, pricing, sale and purchase.

15. How is direct comparison made in measurement?

Ans: In the direct comparison method, the parameter to be measured is directly compared with either a primary or a secondary standard. In this method, the comparison is done with a standard through use of a calibrated system. Direct methods are quite common for the measurement of physical quantities such as length, mass and time.

16. How is indirect comparison done in measurement?

Ans: Indirect comparison makes use of some form of transducing device which converts the quantity to be measured into an analogous signal.

17. What is primary measurement? Give examples.

Ans: In primary measurement, any physical parameters are measured by comparing it directly with reference standards. For example: i) Matching of two lengths when determining the length of an object with a ruler. ii) Matching of two weights when determining the mass of the grocery items.

18. What is secondary measurement?

Ans: A secondary measurement is an indirect measurement which involves only one translation to be done on the quantity under the measurement. Ex: conversion of pressure into displacement by bellows.

19.What is tertiary measurement?

Ans: Indirect measurement which involves two translations are called tertiary measurements Ex: the measurement of the speed of a rotating shaft by means of an electric tachometer.

20. Classify measurements.

Ans: i) Contact type ii) Non contact type

21. Name the different methods of measurement.

Ans: Direct method, Indirect method, Comparative method, Coincidence method, Fundamental method, Contact method, Transposition method, Deflection method, Complementary method.

22. Define measurand.

Ans: The physical, chemical, electrical quantity, property, process variable or a condition to be measured is referred as measurand.

23. Define measuring instruments.

Ans: It may be defined as a device for determining the value or magnitude or quantity of a variable.

24. What are the elements of generalized measurement system?

Ans: Primary sensing element, Variable conversion element, Variable manipulation element,
Data transmission element, Data processing element, Data presentation element.

25. Define primary sensing element. (or) What is primary sensing element?

Ans: Primary sensing element is also called detector. It is the first element which receives energy from the measured medium and it produces an output corresponding to the measurand. This output is then converted into an analogous electrical signal by a transducer.

26. Define variable conversion or transducer element.
Ans: Variable conversion element converts the output electrical signal of the primary sensing element (voltage, frequency or other electrical parameter) into a more suitable form signal without changing the information contained in the input signal.
27. Define variable manipulation element with an example.
Ans: Variable manipulation element is used to amplify the input signal to the required magnification. Ex: small voltage as input into greater voltage as output.
28. Define data transmission element with an example.
Ans: Data transmission element transmits the data from one element to the other without disturbing the signal being transmitted. Ex: shaft to gear assembly system – short distance, From test centre to computer – medium distance.
29. What do you mean by data processing element?
Ans: Data processing element is an element which is used to modify the data before displayed or finally recorded. It may be used i) to convert the data into useful form ii) to separate he signal hidden in noise iii) to provide corrections to the measured physical variables to compensate for zero offset, temperature error etc. It removes unwanted disturbances such as noises which come with signal.
30. Define Data presentation element with an example.
Ans: These are the elements that they finally communicate the information of measured variable to a human observer for monitoring, controlling or analysing purposes. Ex: Pointer moving over a scale, Recording of pen moving over a chart.
31. What do you mean by data storage element. Give examples.
Ans: Data storage elements are elements that store the data/information and presents the same when commanded. Ex: magnetic tape recorder, camera, TV equipment and storage type CRT.
32. Name any two self generating instrument.(Passive Instrument)
Ans: i) mercury-in-glass thermometer ii) bourdon gauge for the measurement of pressure. iii) pitot-tube for the measurement of velocity. iv) tacho-generator for rotational speed measurement.
33. Define the term Calibration.

Ans: Calibration is a set of operations that establish the relationship between the values that are indicated by the measuring instrument and the corresponding known value of a measurand.

(or)

Calibration is the process of determining and adjusting an instruments accuracy to make sure its accuracy is within the manufacturers specifications.

34. Differentiate Accuracy and Precision.

Ans: The closeness of the measured value with respect to the true value is called as **accuracy**.

Precision refers to the ability of an instrument to reproduce its readings again and again in the same manner for a constant input signal.

35. Write short notes on ISO.

Ans: The **International Organization for Standardization** (**ISO**) is an international standard-setting body composed of representatives from various national standards organizations. ISO International Standards ensure that products and services are safe, reliable and of good quality.

36. Define the term Sensitivity.

Ans: Sensitivity is defined as the ratio of the change in output of the instrument to a change of input or measured variable. It denotes the smallest change in the measured variable to which the instrument responds. Example: An Instrument has a scale reading of 0.01mm to 100mm. Here, the sensitivity of the instrument is 0.0lmm i.e. the minimum value in the scale by which the instrument can read.

37. What are the five elements of metrology?

Ans: Five elements of Metrology are i) Standard ii) Work piece iii) Instrument iv) Persons v) Environment

38. Define the terms Repeatability and Reproducibility.

Ans: Repeatability: Repeatability is the closeness between successive measurements of the same quantity with the same instrument by the same operator over a short time span.

Reproducibility: Reproducibility is the degree of closeness between measurements of the same quantity where the individual measurements are made under different conditions.

39. What is Traceability?

Ans: Traceability is defined as the ability to trace the accuracy of a standard back to its ultimate source of standard.

40. Compare the terms range and span.

Sl.No	Range	Span
01.	The region between which the	Span is the algebraic difference

	instrument is to operate is called range. i.e. Range = L_c to H_c	between the higher calibration value and the lower calibration value. i.e. span = H_c-L_c
02.	e.g. The range of thermometer is 0°C to 100°C	The span of thermometer is 100 – 0 = 100°C

41. Differentiate between sensitivity and range with suitable example.

Ans: **Sensitivity** is defined as the ratio of the change in output of the instrument to a change of input or measured variable. Units are mm/micro-ampere, counts/roh, etc depending upon the type of input and output.

Range is the minimum and maximum values of a quantity for which an instrument is designed to measure.

Example: An Instrument has a scale reading of 0.01mm to 100mm. Here, the sensitivity of the instrument is 0.0lmm i.e. the minimum value in the scale by which the instrument can read. The range is 0.01 to 100mm i.e. the minimum to maximum value by which the instrument can read.

42. Define a measuring instrument.

Ans: A measuring instrument is a device that has many components to perform a particular function. It is used to determine the value of physical quantities such as length, weight, pressure, force etc.

43. What are the facilities that should be provided by the intelligent instrument?

Ans: Good precision, 100% accuracy and repeatability.

44. Define the standard of measurement.

Ans: Standard is a physical representation of a unit of measurement. A known accurate measure of physical quantity is termed as Standard.

45. Classify Standards.

Ans: i) International standards ii) Primary standards iii) Secondary standards iv) Working standards.

46. Define International Standards.

Ans: International Standards are defined by International agreement. They are periodically evaluated and checked by

absolute measurements of fundamental units of physics. They represent certain units of measurement to the closest possible accuracy attainable by the science and technology of measurement. These international standards are not available to ordinary uses such as measurement and calibrations.

47. Define Primary standards.

Ans: The main function of the primary standard is the calibration and verification of secondary standards. Primary standards are maintained at the National Standards Laboratories in different countries. For India, it is National Physical Laboratory at New Delhi. These primary standards are not available for the use outside the National Laboratory. These primary standards are absolute standards of high accuracy which can be used as ultimate reference standards to check , calibrate and verify the secondary standards.

48. Define Secondary Standards.

Ans: Secondary standards are the basic reference standards used by the measurement and calibration laboratories in industries. These secondary standards are maintained by the particular industry to which they belong. Each industry has its own secondary standard. Each laboratory periodically send its secondary standard to the national standards laboratory for calibration and comparison against the primary standard. After comparison and calibration, the national standards laboratory returns the secondary standards to the particular industrial laboratory with a certification of measuring accuracy in terms of primary standard.

49. Define Working standards.

Ans: working standards are the main tools of a measuring laboratory. These standards are used to check and calibrate laboratory instrument for accuracy and performance. Ex: Manufacturing of mechanical components such as shafts, bearings, gears etc. use a standard called working standard for checking the component dimensions.

50. Mention the categories of units with examples.

Ans: i) Fundamental Units: metre, kilogram, second, Ampere, Kelvin, mole, candela.

ii) Supplementary Units: Radian for plane angle, Steradian for solid angle.

iii) Derived Units: Units which are derived from fundamental and supplementary units.

Mechanical units: mass, velocity, acceleration, force weight, torque, work, energy, power et.

Electrical units: ohms, frads, henries, energy, power etc.

Magnetic units: webers, tesla

Thermal units: latent heat, specific heat capacity, sensible heat, calorific value etc.

51. Define readability.

Ans: Readability is defined as the ease with which readings may be taken with an instrument. Readability is defined as the closeness with which the scale of an analog instrument can be read. It is the susceptibility of a measuring device to have its indications converted into meaningful number. Fine and widely spaced graduation lines ordinarily improve the readability.

52. Define Uncertainity.

Ans: It is an expression of the fact that for a given result of measurement, there is not one value but infinite number of values dispersed about the result with varying degree of credibility.

True value = Estimated value $\pm$ Uncertainty

53. Define reliability.

Ans: Reliability is the ability of a person or system to perform and maintain its functions in routine circumstances. It is also defined as the consistency of a set of measurements or measuring instrument, often it is used to describe a test.

54. Why instruments are to be calibrated?

Ans: Calibration is necessary to get meaningful results. In cases where sensing system and measuring system are different, it is then imperative to calibrate the system as an integrated whole to take into account the error producing properties of each component.

55. What is resolution?

Ans: It is the smallest increment in the measured value which can be detected with certainity by the instrument.

56. Differentiate static and dynamic response.

Ans: The behaviour of systems subjected to inputs that do not vary with time is termed as static response. The behaviour of systems subjected to dynamic inputs (continuously changing) is termed as dynamic response.

57. State the static characteristics of simplified measuring system.

Ans: Accuracy, Precision, Sensitivity, Resolution, Threshold, Drift, Error, Repeatability, Reproducibility, Dead zone, Backlash, True value, Hysteresis, Linearity, Range or Span, Bias, Tolerance, Stability.

58. State the dynamic characteristics of simplified measuring system.

Ans: Steady state periodic, Transient, Speed of response, Measuring lag, Fidelity, Dynamic error

59. Define i) Threshold ii) Drift

Ans: Threshold: Minimum value of input below which no output can be appeared is known as threshold of the instrument.

Drift: *Drift or Zero drift* is variation in the output of an instrument which is not caused by any change in the input; it is commonly caused by internal temperature changes and component instability.

60. Define i) Dead zone ii) Backlash

Ans: Dead zone: This is the range of different input values over which there is no change in output value.

Backlash : Lost motion or free play of mechanical elements are known as backlash.(or) Backlash is the maximum distance through which one part of the instrument may be moved without disturbing the other part.

61. What is hysteresis?

Ans: Hysteresis is defined as the difference in the output for a given input when this value is approached from the opposite direction.

62. Define the term error. How is it related to accuracy?

Error is the difference between the measured value (V_m) and the true value (V_t) of a physical quantity.

Error = $\pm$ (V_m-V_t), + => Positive error, - => Negative error.

Accuracy represents the degree of correctness of the measured value with respect to the true value.

63. Define systematic error.

Ans. A constant uniform deviation of the operation of an instrument is known as systematic error. Instrumentation error, environmental error and observation errors are systematic errors. Systematic errors are called controllable errors, because it can be easily determined and reduced.

64. Define random error.

Ans: These types of errors occur randomly and reason for this type of error cannot be specified. These errors are due to unknown causes and they occur even when all systematic errors have been accounted. These errors are an accumulation of a large number of small effects and may be of real concern only in measurements requiring a high degree of accuracy.

65. Define dynamic error.

Ans. Difference between the true value of the quantity changing with time & the value indicated by the measurement system. Dynamic errors are caused by inertia, friction and clamping action.

Types of dynamic error are i) Systematic or controllable errors ii) Random error.

66. Define instrument error.

Ans. It is the error due to poor design / construction of the instrument.

67. What are the sources of error?

Ans: i) physical nature of components ii) Linearity, hysteresis, repeatability and resolution iii) Interpolation iv) Environmental

conditions v) loading vi) time variations in the measurand vii) calibration vii) variation in atmospheric conditions.

68. Differentiate between systematic errors and random errors.

Ans:

S.No.	Systematic Errors	Random Errors
1.	Can be controlled by magnitude and sense.	Cannot be determined from the knowledge of measuring system.
2.	It is repetitive in nature.	It is non consistent.
3.	This errors are due to improper conditions.	This errors are in he measuring system.
4.	Can be determined and reduced.	Cannot be eliminated.
5.	Induced by variation in atmospheric conditions.	These are due to displacement of level joints due to friction.

69. Differentiate between Line standard and End standard.

Ans:

S.No.	**Line Standard**	**End Standard**
1.	When a length is measured as a distance between centers of two engraved lines, it is called Line standard.	when length is expressed as the distance between two flat parallel faces, it is known as end standard.
2.	Scale is quick and easy to use over a wide range.	more time needed for measurement
3.	Scale markings are not subjected to wear, but the leading edges are subjected to wear.	They are subjected to wear on their measuring faces.
4.	subjected to parallax error.	Not subjected to parallax error.

PART – B QUESTIONS

1. Explain the need for measurement
2. Differentiate between precision and accuracy with suitable example.
3. Write short notes on i) repeatability ii)Accuracy iii)Sensitivity iv)Uncertainty
4. Define precision, accuracy and readability with respect to measurement.
5. Explain in detail the basic element of the accuracy of measuring systems.
6. State the requirements for an instrument to measure accurately.
7. Draw the block diagram of a generalized measurement system and explain the various stages with an example.
9. What are the various possible sources of errors in measurements? What do you understand by systematic error and random errors?
10. Explain in detail various types of errors that may arise in engineering measurements.
11. Discuss on geometric and dimensional tolerancing with suitable examples.
12. What are elements of a measuring system? How they affect accuracy and precision?

UNIT - 2 LINEAR AND ANGULAR MEASUREMENTS
PART -A QUESTIONS WITH ANSWERS

1. Mention the various applications of a vernier.
Ans: Vernier is used to measure the linear distance, height of any objects, depth of drilled holes and marking purposes.
2. What are the possible sources of errors in micrometer?
Ans: The following are some of the possible sources of errors in micrometer: i) Lack of flatness of the anvil ii) Lack of parallelism of the anvils at some, or all parts of the scale iii) inaccurate setting of the zero reading iv) iv) Inaccurate readings following the zero position and v) Inaccurate readings shown by the fractional divisions on the thimble.
3. Define slip gauges.
Ans: Slip gauges are linear measuring instruments, rectangular blocks of steel having a cross section of about 30 x 10 mm, with required thicknesses.
4. How will you wring two slip gauges?(or) What is wringing of slip gauges?
Ans: The wringing of slip gauges are accomplished by pressing the faces into contact and then imparting a

small twisting motion whilst maintaining the contact pressure. The contact pressure is just sufficient to hold the two slip gauges in contact and no additional internal pressure.

5. Name the different grades of slip gauges according to Bureau of Indian Standards.

Ans: IS 2984 – 1966, Bureau of Indian Standards for slip gauges specifies three grades of slip gauges namely grade 0, grade I and grade II.

6. Define interferometry.

Ans: Interferometry is a field of science used to measure the surface nature by using light wave interference.

7. Define optical flat.

Ans: An optical flat is a circular piece of optical glass or fused quartz having its two plane faces flat and parallel and the surfaces are finished to an optical degree of flatness.

8. Mention the various light sources for interferometry.

Ans: Mercury, cadmium, krypton, thallium, sodium, helium, neon and gas lasers.

9. Mention the applications of interferometry.

Ans: Surface flatness testing, surface contour testing, testing the parallelism of any surface with reference to a standard optically flat surface are some of the applications of interferometry.

10. Define comparators.

Ans: Comparators are the measuring instruments which give only dimensional differences in relation to a basic dimension. It can compare the unknown dimensions of a part with some standard or master setting.

11. Mention the various types of comparators available. (or) Classify the comparator according to the principles used for obtaining magnification.

Ans: Mechanical comparators, mechanical-optical comparators, electrical and electronic comparators, pneumatic comparators, fluid displacement comparators, projection comparators, multi-check comparators and automatic gauging machines.

12. Mention the various applications of comparators.

Ans: The following are some of the ways in which the comparators used : i) In mass production, where components are to be checked at a very fast rate. ii) As laboratory standards from which working or inspection gauges are set and correlated. iii) For inspecting newly purchased measuring gauges and iv) Comparators can be used as working gauges to prevent work spoilage and to maintain required tolerances at all stages of manufacturing by attaching with the machines.

13. Define sine principle of measuring angles.

Ans: The sine principle of measuring angles is the angle included between two line is given by the $\sin^{-1}$ of term of the

ratio between the opposite side and the hypotenuse of a right triangle.

14. Define sine bar and mention its limitation. (or) What are the limitations of sine bar?

Ans: Sine bar is an angular measuring device working on the sine principle. The devices operating on sine principle are capable of 'self generation'. i) So the measurement is usually limited to 45^0 from loss of accuracy point of view. ii) Physically difficult to hold in position iii) Slight errors in sine bars cause large angular errors iv) Size of parts to be inspected by sine bar is limited.

15. Differentiate between sine bar and sine centre.

Ans: Sine bar is used for locating any work to a given angle and to change unknown angle.

The conical work is difficult to mount on sine bars, to overcome this sine centre is used. In this two blocks are mounted on top surface of sine bar at each end, these block have centres and can be clamped at any position. Due to the work being held axially between centres, the angle of inclination will be half the included angle of the work.

16. Why the sine bars are impractical and inaccurate as the angle exceeds 45^0?

Ans: The sine bars are impractical and inaccurate as the angle exceeds 45^0, because of the following reasons: i) The sine bar is physically clumsy to hold in position. ii) The body of the sine bar obstructs the gauge block stack even if relieved. iii) Slight errors of the sine bar cause large angular errors. iv) Long gauge stacks are not nearly as accurate as when compared with shorter gauge blocks. v)Temperature variation affects the accuracy.

17. Define angle dekkor.

Ans: Angle dekkor is an optical instrument used for the measurement of small angular differences, changes or deflection, plane surface inspection etc.

18. State the various uses of angle dekkor.

Ans: The angle dekkor is used in the measurement of angle of a component i) Checking the slope angle of a V-block. ii) Measurement of angle of cone or taper gauge and iii) Precise angular setting of machines for operations.

19. What is the constructional difference between an autocollimator and an angle dekkor?

Ans: The illuminated target used in the auto collimator is replaced by an illuminated scale on a glass screen which is set in the focal plane of the objective lens.

20. Write the constructional requirements of the sine bar for accurate measurement.

Ans: i) The rollers must have equal diameter and equal cylinders. ii) The rollers must be placed parallel to each other

and also to the upper face. iii) The accurate center to center of rollers must be known. iv) The top surface of the bar must be flat with high degree of accuracy.

21.Write the difference between comparator and measuring instrument.

Ans: Comparators are the measuring instruments which give only dimensional differences in relation to a basic dimension. It can compare the unknown dimensions of a part with some standard or master setting. e.g. Dial gauge used as mechanical comparator.

Measuring instruments are measuring devices that transform the measured quantity or a related quantity into an indication or information. e.g. Equal arm balance.

22. State the working principle of an electronic comparator.

Ans: In an electronic comparator, transducer induction or the principle of application of frequency modulation or radio oscillation is followed.

23. What are the advantages of electrical and electronic comparator?

Ans: i) It has less number of moving parts. ii) Magnification obtained is very high. iii) Two or more magnifications are provided in the same instrument to use various ranges. iv)The pointer is made very light so that it is more sensitive to vibration.

24. What are the considerations while manufacturing the slip gauges?

Ans: The following additional operations are carried out to obtain the necessary qualities in slip gauges during manufacture. 1. First the approximate size of slip gauges is done by preliminary operations. 2. The blocks are hardened and made wear resistant by a special heat treatment process. 3. To stabilize the whole life of blocks, seasoning process is done. 4. The approximate required dimension is done by a final grinding process.

25. How do you calibrate the slip gauges?

Ans: Comparators are used to calibrate the slip gauges.

26. List the various linear measurements?

Ans: (i) Length (ii) Heights iii) depth and (iv) Thickness

27. What are the various types of linear measuring instruments?

Ans: The various devices used for measuring the linear measurements are i.Vernier calipers ii. Micrometers iii. Slip gauge or gauge blocks iv. Comparator

28.What is the main difference between linear and angular measurement?

Ans: The main difference between linear and angular measurement is that no absolute standard is required for angular measurements.

29. What are the chances of errors in using Sine bars?
Ans: i) Error in distance between rollers ii) Error in slip gauge combination iii) Error in checking of parallelism iv) Error in equality of size of rollers and cylindricity v) Error in parallelism of roller axes with each other. vi) Error in flatness of the upper surface of sine bar.
30. List out any four angular measuring instrument used in metrology
Ans: (i) Angle gauges (ii) Divided scales (iii) Sine bar with slip gauges (iv) Autocollimator (v) Angle dekkor
31. Why Laser is preferred in Engineering Metrology?
Ans: Laser is preferred in Engineering Metrology because of its properties such as high precision, high accuracy, rapid non contact gauging of soft, delicate or hot moving parts.
32. What is the need for a comparartor?
Ans: i) Mass production which characterizes so many branches of modern manufacture would be impossible, if components could not be produced to close dimensional tolerances. ii) Little or no skill is required from the operator. iii) Consistency of measuring operation would be of a high standard.
33. List down the errors when vernier caliper is used in measuring instruments.
Ans: i) Errors may arise in manipulation of readings in the vernier caliper. ii) Jaw movement should be perpendicular to the scale readings. Otherwise, measurements will not be correct. iii) Contact portion of measuring jaws should be good. iv) During internal measurements, the jaws may become bowlegged, which should be checked frequently.
34. What are the precautions to be carried while using vernier caliper?
Ans: i) Jaws should not be used as a wrench or hammer, because it is not a rugged instrument. ii) It should not be used with oil, grit and chips in parts to be measured. iii) One hand of operator should be used for stationary jaw and the other hand for supporting the movable jaw while measuring. iv) Operator should wear eye-glass and magnifying glass during measurement, because accuracy of measurement depends on the sensing of sight and sense of touch.
35. Give the advantages of Digital Vernier Caliper.
Ans: i) Simplest of vernier instruments and very important in tool room die making and similar application. ii) Direct reading iii) Provides long measurement ranges.
36. What is Laser Micrometer?
Ans: Laser Micrometer is used for checking the profiles of complex components like turbine blades.
37. Write short notes on precautions to be taken while using Micrometer.

Ans: i) Preserving the equipment in such a way that it has to be free from dirt and other inclusions. ii) Micrometer should be always held on the right hand and the part to be measured on the left hand. iii) Errors may occur due to lack of flatness and parallelism of anvils and incorrect zero setting.

38. What are the precautions to be taken, while using slip gauges?

Ans: i) Blocks are removed from the set, cleaned and wrung together with minimum number of blocks to form a stack of required dimensions. ii) Wear pieces are included at each end of the stack wherever possible as they provide protection against damage to the lapped faces of the blocks iii) After use the blocks are reoiled or greased to protect the faces from corrosion.

39. How the gauge blocks are selected to built-up the length of 45.525mm

Ans: 45.525 = 1.005 + 1.02 + 1.5 + 2 + 40.Therefore totally 5 gauge blocks are selected.

40. State the advantages of Mechanical Comparators. (or) State any four advantages of reed type mechanical comparator**.**

Ans: i) Cheaper in comparison to other devices of amplifying ii) These instruments do not require any external supply such as electricity or air and as such the variations in outside supplies do not affect the accuracy. iii) Instruments usually have a linear scale, which is easily understood. iv) Robust, compact and easy to handle. V) suitable for ordinary workshop conditions.

41. . Mention any two disadvantages of reed type mechanical comparator.

Ans: (i) Accuracv of the comparator mainly depends on the accuracy of the rack and pinion arrangement. Any slackness will reduce accuracy. (ii) It has more moving parts and hence friction is more and accuracy is less.

42. How are all mechanical comparator effected? (or) How the Mechanical comparator works?

Ans: The method of magnifying small movement of the indicator in all mechanical comparators are effected by means of levers, gear trains or a combination of these elements.

43. State the best example of a mechanical comparator.

Ans: A dial indicator or dial gauge is used as a mechanical comparator.

44. Define least count and mention the least count of a mechanical comparator.

Ans: Least count. - The least value that can be measured by using any measuring instrument known as least count. Least count of a mechanical comparator is 0.01 mm

45. How the mechanical comparator is used? State with any one example.

Ans: Let us assume that the required height of the component I is 32.5mm. Initially, this height is built up with slip gauges. The slip gauge blocks are placed under the stem of the dial gauge. The pointer in the dial gauge is adjusted to zero. The slip gauges are removed- Now, the component to be checked is introduced under the stem of the dial gauge. If there is any deviation in the height of the component, it will be indicated by the pointer.

46. Which part is more sensitive in a mechanical comparator?

Ans: Plunger or Stem.

47. What are the major types of on electrical comparator?

Ans: An electrical comparator consists of the following three major parts such as (i) Transducer
(ii) Display device as meter (iii) Amplifier

48. On what basis the transducer works?

Ans: An iron armature is provided in between two coils held by a leaf spring at one end. The other end is supported against a plunger. The two coils act as two arms of an A.C. wheat stone bridge circuit.

49. How is the accuracy of an electrical comparator checked?

Ans: To check the accuracy of a given specimen or work, first a standard specimen is placed under the plunger. After this, the resistance of wheat stone bridge is adjusted that the scale reading shows zero. Then the specimen is removed. Now, the work is introduced under the plunger.

50. Mention the important parts of an electronic comparator.

Ans:(i) Transducer (ii) Oscillator (iii) Amplifier (iv) Demodulator (v) Meter

51. What are the disadvantages of electrical and electronic comparator?

Ans: (i) External agency is required to metre for actuation. (ii) Variation of voltage or frequency may affect the accuracy of output. (iii) Due to heating coils, the accuracy decreases. (iv) It is more expensive than mechanical comparator.

52. Classify pneumatic comparators.

Ans: (i) Flow or Velocity type. (ii) Back pressure type

53. List the various parts of an optical comparator

Ans: The optical comparator consists of the following parts such as (i) Pivoted lever.(ii) Objective lens (iii) Scale (iv) Plunger (v) Table and (vi) Base.

54.What are the advantages of pneumatic comparator?

Ans: (i) The wear of measuring heads is avoided due to absence of direct contact. (ii) Friction is less due to less number of moving parts. (iii)Work piece is cleaned by supplying of all during the measurement.

(iv)High magnification is possible. (v)There is no interference of measuring head and indicating device because the measuring head is kept away from the indicating device. (vi)It is a suitable method to check ovality and taperness of circular bore.

55. What is the use of Auto-Collimator in mechanical measurements?

Ans: Auto-Collimator is an optical instrument used for measurement of small angular differences, changes or deflection, plane surface inspection etc.,

56. Name any two materials commonly used for gauges.

Ans: i) steel ii) Plastic iii) Glass

57. What are the basic components of Comparators?

Ans: i) sensing device ii) Amplifying system iii) Display system

58. What are Limit gauges?

Ans: Limit gauges are used as inspecting gauges, Also used in inspection by method of attributes. It gives the information about the products which may be either within the prescribed limit or not.

59. A 250mm sine bar is to be set to an angle of 35°5'6". Find the height of gauge blocks required using any appropriate set of gauge blocks.

Ans: L - Length of sine bar = 250mm θ = 35°5'6" $\sin\theta = h / L$

Height of gauge blocks required $h = L \cdot \sin\theta = 250 \times \sin 35°5'6" = 143.7$mm

60. State any four applications of pneumatic comparator.

Ans: i) Plate straightness ii) Squareness of bore iii) Snap gauge iv) Height and depth gauge v) Solex air ring gauge.

61. Define Interchangeability.

Ans: A part which can be substituted for the component manufactured to the same shape and dimension is known as the interchangeable part. The operation of substituting the parts for manufactured components of the same shape and dimension are called interchangeability.

62. Write short notes on Dimensional tolerance and Form tolerance.

Ans: It is the size whose limit dimensions are specified using the upper and lower deviations. In case of a fit, the basic size of both connected elements must be the same. The Tolerance of a size is defined as the difference between the upper and lower limit dimensions of the part.

PART – B QUESTIONS

1. With neat sketch explain the construction and working principle of differential pneumatic comparator.
2. With neat diagram explain the construction and working principle of depth micrometer?
3. What is auto collimator? With neat sketch explain the working principle of micro-optic auto collimator?
4. Write the advantages and disadvantages of the mechanical comparator?
5. Explain with a schematic sketch the working principle of solex pneumatic comparator.
6. Describe the working principle, advantages and disadvantages of optical comparators.
7. Describe the method of checking the angle of a taper plug gauge using rollers, micrometer and slip gauges.
8. Explain the working principle of Angle dekkor.
9. Explain the working principle of autocollimator and briefly explain its application
10. Describe with the help of a near sketch, a vernier bevel protractor
11. How and angle dekkor differ from and Auto-Collimator?
12. What types of measuring systems are used for linear distance?
13. Describe an opto-mechanical comparator.

UNIT - 3 ADVANCES IN METROLOGY
PART -A QUESTIONS WITH ANSWERS

1. Define laser and laser instrument.

Ans: Laser is the acronym of Light Amplification by Stimulated Emission of Radiation.

Laser instrument is a device which produces powerful, monochromatic, collimated beam of light. The waves in the beam of light are coherent.

2. State the advantages of coherent light.

Ans: The advantage of coherent light is that whole of the energy appears to be emanating from a very small sharp point and the beam can be focused into either a parallel beam or onto a very small point by using lenses.

3. State the principle of laser.

Ans: When the photon comes from higher energy level to lower energy level, it releases another photon. The sequence of triggered identical photon from stimulated atom is known as stimulated emission. This multiplication of photon through stimulated emission leads to coherent, powerful, monochromatic, collimated beam of light emission. This light emission is called laser.

4. What is laser micrometer?

Ans: Laser micrometer is a measuring device used for checking the profiles of complex components like turbine blades.

5. Name the various optical elements used in laser interferometry.

Ans: The following are some of the optical elements used in laser interferometry:

i) Beam splitter ii) Beam benders and iii) Retro reflectors.

6. Mention the various components present in the laser interferometry.

Ans: The various components present in the laser interferometry are two frequency laser source, optical elements, laser head's measurement receiver and measurement display.

7. What are the advantages of Laser in interferometry? (or) What is the advantage of using Laser beam Interferometry?

Ans: Laser provides a source of coherence and truly monochromatic light. The property of clearance enables it to be projected in a narrow pencil of beam without any scatter.

8. Briefly explain two frequency laser source.

Ans: Normally He-Ne type generates stable coherent light beam of two frequencies with one polarized vertically and another horizontally relative to the plane of the mounting feet. This laser oscillates at two slightly different frequencies by a permanent magnet of cylindrical shape around the cavity. The two components of frequencies are distinguishable by their opposite circular polarization.

9. State the advantages of Laser Interferometer.

Ans: i) ideally suited for measuring linear position, straightness in two planes. ii) High Sensitivity iii) Free form noise disturbance iv) offers high accuracy and resolution.v) Long measuring range.

10. List the various techniques for dimensional measurements using Laser.

Ans: i) Scanning Laser Gauge ii) Photo Diode Array Imaging iii) Diffraction Pattern Technique iv) Laser Triangulation Sensors v) Two Frequency Laser Interferometer.

11. Mention the various advantages of AC laser interferometer.

Ans: The advantages of AC laser interferometer are listed below:
* High repeatability * High accuracy * Long range optical path * Easy installation * Wear and tear are less.

12. Mention the applications of two frequency laser interferometer.

Ans: Two frequency laser interferometer is used to measure displacement, high precision measurements of length, angle, speed and refractive indicies as well as derived static and dynamic quantities.

13. State the differences between DC and AC Laser Interferometers.

Ans:

S.No.	DC Laser Interferometer	AC Laser Interferometer
1.	Here interference occurs between two beam at the same frequency.	Here two beam of slightly different frequency are combined to produce a beam.
2.	A single frequency laser source is required.	Here highly stabilised two frequency and more intricate detector electronics are required.
3.	Displacement information is carried on a DC signal.	Displacement information is carried on a AC signal.
4.	Laser source intensity level changes, ambient light and various other noises affect measurements.	This system is less sensitive to all such problems.

14. What is the purpose of Retro-reflectors in Laser Interferometers?

Ans: Retro-reflector is a device or surface that reflects light back to its source with a minimum scattering light and also reflects the beam always parallel to the incident beam in these devices.

15. Why Laser is preferred in engineering metrology?

Ans: Laser is preferred in Engineering metrology, because of its properties such as high precision, high accuracy, rapid non-contact gauging of soft or hot moving points.

16. State the functions of the following in Laser Interferometer – i) Compensating plate ii) Quarter wave plate.

Ans: i) Compensating Plate: A compensating plate, made of the same material (glass) and of the same thickness as the beam splitter, is placed along the path on the right, parallel to

the beam splitter, to equalize the distances each beam travels through glass. When white light source is used then a compensator plate is introduced in each of the path of mirror So that exactly the same amount of glass is introduced in each of the path.

ii) Quarter Wave Plate: Quarter wave plate can convert linearly polarized light into circularly polarized light and vice-versa. A quarter wave plate can be used to produce elliptical polarization as well.

17. State the functions of the following in AC Laser Interferometer – i) Amplifiers ii) Photo-detector

Ans: i) Amplifiers: Amplifiers are used to separate the frequency difference signal.

ii) Photo-detectors: Photo-detectors receive the signal from the beam splitter and they change into electrical signal. Photo-detectors connected to high speed counters can count fringes easily, which are difficult with the eye.

18. What are Diffraction Gratings?

Ans: D**iffraction Grating** is an optical component with a periodic structure, which splits and diffracts light into several beams travelling in different directions. The directions of these beams depend on the spacing of the grating and the wavelength of the light so that the grating acts as the dispersive element. Because of this, gratings are commonly used in monochromators and spectrometers.

19. Define the terms i) Amplitude ii) Time Period iii) Wavelength iv) Frequency

Ans: Light can be considered as an electro-magnetic wave of sinusoidal form. The high point of the wave is called the **crest** and the low point is called **trough**. The distance between two troughs or two crests is called the **wavelength**. The time taken in travelling one wavelength is called the **time period**. The maximum disturbance of the wave is called the **amplitude** and velocity of transmission being called the **frequency**.

20. What are the advantages of laser in interferometer? (or) What is Interferometer?

Ans: Lasers are used in Interferometer for measuring flatness and determining the lengths of slip gauges by direct reference to the wavelength of light.

21. Name the different types of interferometer?

Ans: i) NPL flatness interferometer ii) Michelson interferometer iii) Laser interferometer iv) Zesis gauge block interferometer.

22. Name the common source of light used for interferometer

Ans: (1) Mercury 198 2) Cadmium 3)Krypton 86 4)Helium 5)Hydrogen

23. Why is monochromatic light used in interferometry instead of white light?
Ans: Monochromatic light is used to suit radiations other than light. Most unusual feature of the interferometer is its high tolerance to large misalignments of its optical elements.
24. State the principle of interferometry.
Ans: Two light rays from the same monochromatic light source can be combined to give a bright or dark surface by changing the phase difference between them. The brightness or darkness can then be a measure of displacement.
25. Why are lasers used in Metrology? (or) Why laser is used in alignment testing?
Ans: The alignment tests can be carried out over greater distances and to a greater degree of accuracy using laser equipment. Laser equipment produces real straight line, whereas an alignment telescope provides a, imaginary line that cannot be seen in space.
26. Define concentricity.
Ans: Concentricity is defined as the matching of components like hollow shafts and spindles in a same line of operation or in a single centre.
27. Define axial slip of a machine tool.
Ans: Axial slip of a machine tool is defined as the axial movement of the spindle which follows the same pattern and is due to the manufacturing error.
28. Distinguish between coordinate and conventional metrology.
Ans: In coordinate metrology, the linear dimensions in three coordinates are carried out by using the machines. In conventional metrology, it is not possible to carry out the linear measurements in three coordinates.
29. What do you mean by the alignment test on a machine tool?
Ans: The alignment test on a machine tool is carried out to check the grade of manufacturing accuracy of the machine tool.
30. Mention the various geometrical checks made on machine tools.
Ans: The geometrical checks made on machine tools are :* Straightness and flatness of guide ways and slide ways of machine tool. * Flatness of machine tables * Parallelism, equidistance and alignment of the slide ways. * True running and alignment of shaft and spindle. * Lead of lead screw or error in pitch.
31. Differentiate geometrical test and practical test on a machine tool.
Ans: * The geometrical test is carried out to check the grade of manufacturing accuracy of the machine tool.

Practical test is carried out to check the accuracy of the finished component.

* Geometrical test consists of checking the relationship between various machine elements when the machine tool is idle. * Practical test consists of preparing the actual test jobs on the machine and checking the accuracy of the jobs produced.

32. What are the main spindle errors?

Ans: a) Out of round. b) Eccentricity c) Radial throw of an axis. d) Run out e) Periodical axial slip f) Camming

33. Write the various tests conducted on any machine tools

Ans: 1. Test for level of installation of machine tool in horizontal and vertical planes. 2. Test for flatness of machine bed and for straightness and parallelism of bed ways on bearing surface. 3. Test for perpendicularity of guide ways to other guide ways. 4. Test for true running of the main spindle and its axial movements.

34. Classify the machine tool test.

Ans: It can be classified into 1. Static tests 2. Dynamic tests.

35. Define axial length measuring accuracy

Ans: it is defined as difference between the reference length of gauges aligned with a machine axis and the corresponding measurement results from the machine.

36. Define volumetric length measuring accuracy

Ans: it is defined as difference between the reference length of gauges, freely in space and the corresponding measured results from the machine

37. What are the steps involved in producing software for engineering metrology?

Ans: i) precise and detailed definition of geometrical form ii) specification of the measurement procedure

iii) mathematical modeling of the measurements.

38. Mention the various types of measuring machines.

Ans: Measuring machines are classified as: i) Length bar measuring machine ii) Newall measuring machine iii) Universal measuring machine iv) Coordinate measuring machine and v) Computer controlled coordinate measuring machine.

39. What is CMM?

Ans: CMM stands for Coordinate Measuring Machine and it measures the linear dimensions in three coordinates for various components. These machines have precise movement in X, Y and Z coordinates which can be easily controlled and measured. Slide in each direction is equipped with a precision linear measurement transducer which gives digital display and senses positive and negative directions.

40. Define position accuracy.

Ans: Position accuracy is defined as the difference between the positions read out of machine along an individual axis and value of a reference length measuring system. Position accuracies in X, Y and Z axis are measured and these three are needed for position accuracy.

41. Mention the various types of coordinate measuring machine.

Ans: Coordinate measuring machine is classified as: i) Cantilever type ii) Bridge type iii Horizontal bore mill iv Vertical bore mill and v) Spherical coordinate measuring machine.

42. Mention the application of CMM in reverse engineering.

Ans: CMM is used to determine the shape, position and maximum metal condition of the component. It also ensures the economic viability of NC machines by reducing their down time for inspection results.

43. Write the features of CMM.

Ans: i) In faster machines with higher accuracies, the stiffness to weight ratio has to be high in order to reduce dynamic forces. ii) All the moving members, the bridge structure Z-axis carriage and Z-column are made of hollow box construction. iii) Errors in machine are built up and fed into the computer system so that error compensation is built up into the software. iv) All machines are provided with their own computers and the CMM is able to measure three-dimensional object from the variable datums.

44. What are the benefits of using CMM. (or) Write some features of CMM software.

Ans: i) can accurately check multiple features on different planes and angles ii) Mininize CNC Program iii) Data Communication iv) Digital input and output command v) Interface to CAD software.

45. Mention the Disadvantages of CMM.

Ans: i) Table and probe may not be in perfect alignment ii) Stylus may have run out. iii) Stylus moving in Z axis may have some perpendicularity errors. iv) stylus while moving in X and Y direction may not be square to each other.

46. Explain CNC, CMM briefly.

Ans: A computer numerical control system can be used with CMM to do calculations while measuring complex parts. Error can be stored in memory while doing calculations. For automatic calibration of probe, determination of co-ordinate system, calculation, evaluation and recording etc., special software's are incorporated.

47. Mention the advantages of CMM.

Ans: i) The inspection rate is increased. ii) Accuracy is increased. iii) Operator's error can be minimized. Skill of the

operator is reduced. iv) Reduction in calculating, recording and set up time. v) No need of GO/NOGO gauges. vi) Reduction of scrap and good part rejection.

48. Name the types of accuracy specification used for CMM.

Ans: i) Geometrical accuracies such as positioning accuracy, straightness and squareness. ii) Tool measuring accuracy in terms of length measuring accuracy iii) Volumetric length measuring accuracy and length measuring repeatability iv) Environmental effects

49. Mention the application of CMM.

Ans: (i) CMM's to find application in automobile., machine tool, electronics, space and many other large companies. (ii) These are best suited for the test and inspection of test equipment, gauges and tools.

(iii) For aircraft and space vehicles of hundred Percent inspections is carried out by using CMM.

(iv) CMM can be used for determining dimensional accuracy of the component. (v) CMM can also be used for sorting tasks to achieve optimum packing of components within tolerance limits.

50. List any four possible causes of error in CMM.

Ans: i) Table of CMM may not have perfect geometric form. ii) Probes may have a degree of round iii) Perpendicularity error when probe is moving up and down. iv) translation error resulting from errors in the scale division and errors in axis direction.

51. Describe the features of a flexible inspection system.

Ans: (i) A powerful computer serves as a real tirne processor to handle part dimensional data and as a multi 'programming system to perform such tasks as manufacturing process control. (ii) The terminal provides interactive communication with personnel Computer where the programmes are stored. (iii) Input devices microprocessor based gauges and other inspection devices are used in CMM.

52. Define machine vision(computer vision or Intelligent vision).

Ans: Machine vision is defined as the means simulating the image recognition and analyse the capabilities of the human system with electronic and electromechanical techniques.

53. What are the advantages of machine vision system? (or) Write the advantages of Computer Aided Inspection.

Ans: The advantages of machine vision system are: * Reduction of tooling and fixture cost * Elimination of precise part location * Detection of defect * Dimensional verification of integrated automation.

54. What are the four stages of machine, vision system?

Ans: (i) Image formation. (ii) Processing of image. (iii) Analyzing the image (iv) Interpretation of image.

55. Define grayscale analysis.

Ans: In these techniques, discrete areas or windows are formed around only the portions of the image to be inspected. For determining if brackets are present, high intensity lighting is positioned so that a bracket, when the bracket is missing no shadow will be cast. When the bracket is present, a large number of darker pixels can be observed in the window due to the cast shadow than when a bracket is missing. A contrast threshold between the dark and light pixel value area can be set. This type of discrete area analysis is a powerful tool which can be used for inspection of absence, correct part assembly, orientation, part, integrity, etc.

56. Explain briefly the three important fields of machine vision system

Ans: Inspection: it is the ability of an automated vision system to recognize well-defined pattern and if these pattern match these stored in the system makes machine vision ideal for inspection of raw materials, parts, assemblies etc.

Part identification: It is the ability of part recognition provides positive identifications of an object for decision-making purposes.

Guidance and Control. Machine vision systems are used to provide sensor feedback for real time guidance.

PART – B QUESTIONS

1. Explain the construction and working principle of laser interferometer with neat diagram? Explain the use of laser interferometer in angular measurement.
2. Describe the working principle of a dual frequency laser interferometer and state its application.
3. Explain the working principle of AC LASER interferometer and how the straightness is measured?
4. Explain in detail the various methods of testing accuracy of horizontal milling machine and lathe using laser interferometer.
5. Sketch and describe the optical system of a laser interferometer.
6. Write a brief note on laser as a means of alignment checking.
7. Discuss the steps involved in computing flatness of surface plate. How are the pitch and yan errors in X direction of table movement measured in a horizontal milling machine by LASER interferometer?

8. How are CMMs classified with respect to constructional features? Sketch and state their main applications, merits and demerits.

UNIT - 4 FORM MEASUREMENT
PART -A QUESTIONS WITH ANSWERS

1.Mention the various terminologies of a screw thread.

Ans: Screw thread, crest, flank, root, lead, pitch, helix angle, flank angle, depth of thread, included angle, major diameter, minor diameter, addendum and dedendum are some of the screw thread terminologies.

2. Name the various types of pitch errors found in screw?

Ans: (i) Progressive error (ii) Drunken error (iii) Periodic error (iv) Irregular errors.

3.Define Drunken thread error.

Ans: In any screw thread if the thread is not cut to the true helix then the Drunken thread error will form. The thread is having erratic pitch in which the advance of helix is not regular in one complete turn of the thread.

4.What is the effect of flank angle error?

Ans: Flank angle error causes a virtual increase in the effective diameter of a bolt and decrease in the effective diameter of the nut.

5. Define: Periodic error.

Ans: The periodic error repeats itself at equal intervals along the thread.

6. What is progressive error in screw threads?

Ans: The pitch of the thread is uniform but it is longer or shorter to its nominal value and this is called progressive error.

7. How will you measure the major diameter of a screw thread?

Ans: The major diameter of a screw thread can be measure by using either ordinary micrometer or bench micrometer.

8. How will you measure the minor diameter of a screw thread?

Ans: The minor diameter of a screw thread can be measured by using either taper parallels or rollers and slip gauges.

9. Define effective diameter of a screw thread.

Ans: Effective diameter is the average of minor and major diameter of screw thread.

10. How will you measure the effective diameter of a screw thread?

Ans: The effective diameter of a screw thread can be measured by using the following methods:
i) One wire method ii) Two wire method and iii) Three wire method.

11. How will you measure the pitch diameter of a screw thread?

Ans: The pitch diameter of a screw thread can be measured by using the following methods:
i) Pitch measuring machine ii) Tool makers microscope and iii) Screw pitch gauge.

12. What is best size of wire?

Ans: Best size of wire is the diameter of the wire in such a way that it makes contact with the flanks of the thread on the pitch line.

13. State the applications of tool maker's microscope.

Ans: Tool maker's microscope is used to a) Measure the linear dimension b) Measure the pitch of a screw c) Measure the thread angle d) Compare the thread forms e) Measure the centre to centre distance.

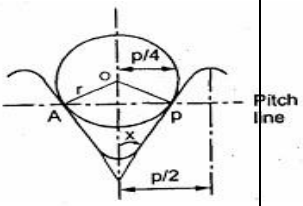
14. Name the two corrections are to be applied in the measurement of effective diameter.

Ans: (i) Rake corrections (ii) Compression correction,

15. Derive the expression for 'Best size of wire' in screw thread measurement.

$$D_b = 2AP \sec x$$

Where , D_b= wire diameter, X= included angle
AP = P/4, Therefore, $D_b = 2(P/4)*\sec x$,
$D_b = P/2*\sec x$



16. List the reasons for the occurrence of progressive pitch errors in screw threads

Ans: i) Incorrect linear and velocity ratio ii) Incorrect gear train and lead screw iii) Saddle fault iv) Variation in length due to hardening.

17. List out the various forms of thread gauges.

Ans: Thread gauges are classified as: i) Plug screw gauge ii) Ring screw gauge and iii) Caliper gauge.

18. What are thread gauges?

Ans: A thread pitch gauge also known as screw pitch gauge or pitch gauge is used to measure the pitch or lead of a screw thread.

19. How Taylor's principle is applied to screw thread gauge?

Ans: Maximum metal condition: It refers to the condition of hole or shaft when the maximum material is left. i.e. high limit of shaft and low limit of hole.

Minimum metal condition: It refers to the condition of hole or shaft when the minimum material is left. i.e. low limit of shaft

and high limit of hole. **Statements**: 1. The GO gauge must be made to check the maximum metal condition. 2. The NOGO gauge must be made to check the minimum metal condition.

20. What are the various measuring attachments in Tool maker's Microscope.

Ans: Microscope is provided with several measuring attachments such as i) Centre stage for mounting of cylindrical components ii) revolving and angle measuring oculars iii) Double image oculars iv) Optical feeder v) Projection screen.

21. Mention the purpose of geometric heads in Tool maker's Microscope.

Ans: Geometric head in Tool maker's Microscope is used to measure circular divisions / dimensions. For example, the flank angle of the gears may be measured using Tool maker's Microscope with a geometric head.

22. What is Floating Carriage Micrometer?

Ans: Two grooves on the table lie parallel to the centers and support the lower carriage. This carriage has two conical pegs resting in one Vee-groove, the opposite of carriage having a flat resting upon a ball which lies in the second Vee-groove of the base. So, the upper surface of the lower carriage has also two vee-grooves on the ball bearings. The upper carriage floats freely on the balls. It is called as floating carriage.

23. What are the commonly used forms of gear teeth?

Ans: (i) Involute (ii) Cycloidal

24. What are the types of gears?

Ans: (i) Spur (ii) Helical (iii) Bevel (iv) Worm and Worm wheel (v) Rack and pinion.

25. Define: Module

Ans: Module = pitch circle diameter/ number of teeth

26. Define: Lead and Lead angle.

Ans: The distance at which a thread advances for one rotation is known as lead. Lead = No. of starts x pitch.

Lead Angle is the angle between the tangent to the helix and plane perpendicular to the axis of cylinder.

27. Mention the various methods used for measuring the gear tooth thickness.(Jun 2014)

Ans: To measure the gear tooth thickness, the methods used are: i) Gear tooth vernier ii) Base tangent method iii) Constant chord method and iv) Measurement over pins or balls.

28. Define backlash.

Ans: Backlash is the distance through which a gear can be rotated to bring its non-working flank in contact with the teeth of mating gear.

29. Name four gear errors.

Ans: (i) Pitch error (ii) Alignment error (iii) Composite error (iv) Thickness error

30. Name the method used for checking the pitch of the gear.

Ans: (i) Step by step method. (ii) Direct angular measurement.

31. Define constant chord.

Ans: Constant chord is defined as the chord joining the points which are on the opposite faces of the tooth.

32. A spur gear of 4 mm module has 60 teeth. Calculate the pitch circle diameter and base pitch for pressure angle of 20^0.

Ans: Pitch circle diameter = Module x number of teeth = 4 x 60 = 240 mm.

Base pitch = Module x π cos(pressure angle) = 4πcos(20) = 11.7 mm

33**.** What are the direct angular measurements methods?

Ans: 1. Profile checking: a) Optical projection method b) Involute measuring method.

2. Thickness measurement: a) Chord thickness method b) Constance chord method.

34. What is Gear runout?

Ans: Gear Run out. -Total range of reading of a fixed indicator with the contact points applied to a Surface rotated, without axial movement, about a fixed axis of a gear.

35. What are the instruments used for direct measurement of surface finish?

Ans: The following instruments used for direct measurement of surface finish:

i) Stylus probe instruments ii) Tomlinson surface meter iii) Profilometer and iv)Taylor–Bobson - Talysurf .

36. Write the formula used for measuring the radius of the circle.

Ans: Radius of the circle $R = [(l - d)^2] / 8d$

Where, R = Radius of the circle

l = Distance between the balls

d = diameter of pins.

37.What are the various factors affecting surface roughness?

Ans: The surface roughness is affected by: i) Work piece material ii) Vibrations of the work and machine iii) Method of machining and iv) Type of tool and fixtures used.

38. Define the term cut - off length with respect to surface roughness measurement.

Ans: The maximum wavelength considered for the measurement of surface roughness is known as cut -off length.

39. Define sampling length and maximum height of irregularity.

Ans: Sampling length is the length of profile necessary for the evaluation of the irregularities to be taken into account.
Maximum height of irregularity is defined as the average difference between the peak and trough.
40. What is the difference between R_z and R_t?
Ans: Maximum profile height Rt is determined from the difference between the highest peak and lowest valley found along the evaluation length.
Average maximum profile height Rz is derived from the average, sampling lengths of the difference between the highest peak and low valley.
41. Define Concentricity.
Ans: It is defined as the matching of components like hollow shafts and spindles in a same line of operation i.e. in a single center.
42. What are the two methods used in measuring radius of concave surface.
Ans: a) Edges are well defined. b) Edges are rounded up.
43. What are the methods used for measuring surface roughness?
Ans: a) Inspection by comparison b) Direct instrument measurements.
44. What are the methods used for evaluating the surface finish?
Ans: i) Peak to valley height method ii) The average roughness method iii) Form factor method.
45. What is secondary texture of a surface?
Ans: Surface irregularities of considerable wavelength of a periodic character are called secondary texture or waviness.

46. Define : lay. Mention any four of its type.
Ans: Lay: -Direction of the 'predominate surface pattern'. Types of Lays are i) Horizontal lay ii) Vertical Lay iii) Radial Lay iv) Circular Lay.
47. Define degree of fullness in form factor.
Ans: Degree of fullness (K) is defined as the ratio between the area of metal present and the area of the enveloping portion.
48. Define degree of emptiness in form factor.
Ans: Degree of emptiness is defined as the ratio between the area of empty space and the total area of the enveloping portion. Degree of emptiness = 1 - K
49**.** Define : flaw
Ans: Flaws. - Surface irregularities or imperfection which occurs at frequent intervals.
50. What do you mean by roundness?
Ans: Roundness is defined as a condition of a surface of revolution where all the surfaces intersected by any plane

perpendicular to a common axis in case of cylinder and cone.

51. Name the various devices used for the measurement of roundness.

Ans: The roundness is measured by i) Diametral gauge ii) Circumferential conferring gauge iii) Rotating on centre iv) Three point probe and v) Accurate spindle.

52. Name the four reference circles used in measurement of roundness.

Ans: i) Least squares circle ii) Minimum zone or minimum radial separation circles iii) Maximum inscribed circle and iv) Minimum circumscribed circle

53. Briefly explain straightness of a line in two planes.

Ans: A line is said to be straight over a given length if the variation of the distance between the two points on the two planes perpendicular to each other and parallel to the direction of a line remaining within the specified tolerance limits.

54**.** Define. Straight edge.

Ans: A straight edge is a measuring tool which consists of a length of a steel of narrow and deep section in order to provide considerable resistance to bending in the plane of measurement without excessive weight.

55. Compare straightness test by using spirit level and autocollimator.

Ans: Spirit level can be used only for the measurement of straightness of horizontal surface, while autocollimator can be used on the surfaces in plane.

In the spirit level, the block is moved along the line on the surface to be tested in steps equal to the pitch distance between centre lines of the feet. But in autocollimator, the instrument is placed at a distance of 0.5m to 0.75m from the surface to be tested.

PART – B QUESTIONS

1. Explain with a neat sketch the working of talysurf instrument for surface finish measurement. What is the symbol for fully defining surface roughness and explain each term?
2. Describe in detail the method of checking roundness by using Roundness Measuring Machine. State its advantages.
3. Define explain the working principle of Tomlinson surface meter with a neat sketch.
4. Define straightness. Describe any one method of measuring straightness of a surface.

5. explain how the straightness error of a Lathe bed is checked using a Auto-collimator
6. With neat sketches, explain the significance of some important parameters used for measuring surface roughness. Why so many parameters are needed?
7. How is surface finish indicated in engineering drawing? What are the various elements indicated in the symbol?
8. How to measure the pitch of the screw thread by using the tool maker's microscope? Discuss in detail.
9. Describe the method of inspecting the profile of spur gear by using involute measuring machine.
10. How to check the composite errors of the gear by using Parkinson gear testing machine? Explain it in detail?
11. Briefly describe major, minor and effective diameter of thread?
12. Describe the two wire method of finding the effective diameter of screw threads.
13. Describe the chordal thickness method and base tangent method using gear tooth vernier calliper.
14. Explain one method of assessing the straightness of a straight-edge.
15. Write notes on the types of irregularities of a circular part and mention its causes.
16. What is the 'best wire size'? Derive an expression for the same in terms of the pitch and angle of the thread,
17. Describe a gear tooth vernier caliper and explain its use for checking tooth thickness and depth of tooth.
18. Explain the principle of measuring gear tooth thickness by base tangent method. What is the span length over 5 teeth of gear having 45 teeth module 4mm and pressure angle 20 degree?
19. Derive the formula for measuring the effective diameter of thread by 3-wire method
20. Draw the set up and explain the measurement of effective diameter of a screw thread using three wires.
21. With the aid of sketch describe the principle of operation of a rolling gear testing machine.
22. Describe a method for inspecting the involute profile of a spur gear tooth.

UNIT - 5 MEASUREMENT OF POWER, FLOW AND TEMPERATURE
PART -A QUESTIONS WITH ANSWERS

1. Define Force.
Ans: Force may be defined as a cause that produces resistance or obstruction to any moving body or change the motion of a body.
2. State any two principles of force measurement.
Ans: i) direct methods ii) indirect methods.
3. Define direct method of force measurement.
Ans: It involves a direct comparison with a known gravitational force on a standard mass, say by a balance.
4. Define indirect method of force measurement.
Ans: It involves the measurement of effect of force on a body, such as acceleration of a body of known mass subjected to force.
5. What is a load cell?
Ans: When the strain gauge – elastic member combination is used for weighing it is called a load cell. Load cells utilize an elastic member as the primary transducer and strain gauge as secondary transducer. Load cells are the devices for the force measurements through indirect methods.
6. What are the direct methods used to measure the force?
Ans: i) Equal arm balance ii) Unequal arm balance iii) Analytical balance iv) pendulum scale
7. List the devices used to measure the force.
Ans: 1. Scale and Balance i) i) Equal arm balance ii) Unequal arm balance iii) Analytical balance iv) pendulum scale 2. Elastic force meter (Proving ring) 3. Load cell i) strain gauge load cell ii) Hydraulic load cell iii) Pneumatic load cell.
8. How is force measured using a Hydraulic load cell?
Ans: When a force is applied on a liquid(oil) medium contained in a confined space, the pressure of the liquid increases which is proportional to the applied force. Hence a measure of the increase in pressure of the liquid becomes a measure of the applied force when calibrated.
9. How is force measured using a Pneumatic load cell?
Ans: If a force is applied to one side of a diaphragm and an air pressure is applied to the other side, some particular value of air pressure will be necessary to exactly balance the force. This air pressure is proportional to the applied force. Hence a measure of this air pressure becomes a measure of the applied force when calibrated.

10. How is force measured using an elastic force meter (Proving ring)?

Ans: When the Proving ring is subjected to a force (tensile or compressive) across its diameter, it deflects. This deflection (relative displacement) which is proportional to the applied force is measured using a precision micrometer or dial gauge or displacement transducer. Hence a measure of this relative displacement becomes a measure of the applied force when calibrated.

11. What is the working principle of unequal arm balance?

Ans: An unequal arm balance works on the principle of moment comparison. The beam of the unequal arm balance is in equilibrium position when: Clockwise rotating moment = Anticlockwise rotating moment

12. What is the working principle of pendulum scale?

Ans: The unknown force is converted into a torque which is then balanced by the torque of a fixed standard mass arranged as a pendulum.

13. Differentiate between primary and secondary Transducers.

Ans:

S.No.	Primary Transducer	Secondary transducer
1.	It is a mechanical device	It is an electrical device.
2.	It converts a physical signal into mechanical signal.	It converts analog output into electrical signal.
3.	Ex. Thermistors and thermocouples.	Ex. Accelerometer and Piezoelectric transducer

14. Brief the basic principle of strain gauge load cell.

Ans: When steel cylinder is subjected to a force, it tends to change in dimension. On this cylinder, strain gauges are bonded and the strain gauge also is stretched or compressed causing a change in its length and diameter. The change in dimensions of strain gauge causes the resistance to change. Measure of change in resistance gives a measure of applied force.

15. Define Torque.

Ans: Torque can be defined as a measure of the tendency of a force to rotate the body on which it acts about an axis.

16. What is the purpose of torque measurement?

Ans: The purpose of torque measurement is to determine the mechanical power required or developed by a machine.

17. Differentiate between force and Torque.

Ans: Force is the load acting on the member. Torque is a rotational force or force through a distance.
Mechanical quantity which changes or tends to change the motion or shape of a body to which it is applied is called Force. Torque can be defined as a measure of the tendency of a force to rotate the body on which it acts about an axis.

18. List the methods employed for measuring Torque.

Ans: i) Torque reaction methods ii) Prony Brake iii) Torque measurement using strain gauges iv) Torque measurement using torsion bars.

19. Name the instruments used for measurement of Torque.

Ans:i) Mechanical Torsion meter **(**Stroboscopic method) ii) Optical torsion meter iii) Electrical torsion meter iv) Strain gauge torsion meter.

20. Define Dynamometer.

Ans: Dynamometer is a device used to measure power and torque produced by an engine.

21. What is the use of D.C. Electric type dynamometer?

Ans: The most versatile and accurate dynamometer is the D.C. Electric type dynamometer. This is a cradled dynamometer and is widely used for power and torque measurements of internal combustion engines, pumps, small steam turbines and other mechanical equipments.

22. How torque is measured using Mechanical torsion meter?

Ans: When a torque is applied to the shaft of the torsion meter, it causes displacement of pointer relative to scale on account of angular twist of the length of the shaft between the two flanges. This angular twist is measured and calibrated in terms of torque.

23. How is torque measured using Electrical torsion meter?

Ans: When a torque is applied to the shaft of the torsion meter, there is a relative displacement between the two slotted discs. This produces a phase shift between the pulses generated in the inductive pickups. When these pulses are compared with the help of an electronic timer, it will show a time interval between the two pulses. This time interval is proportional to the twist of the shaft and hence is proportional to torque.

24. Define Absorption Dynamometers.

Ans: The dynamometer absorbs the mechanical energy when torque is measured. It dissipiates mechanical energy (Heat due to friction) when torque is measured.

25. State any four inferential types of flowmeters.

Ans: Venturimeter, Orificemeter, Rotameter, Pitot tube.

26. Define Flow meter.

Ans: Flow meter is a device that measures the rate of flow or quantity of a moving fluid in an open or closed conduit.

27. How is flow measured using Orifice meter?

Ans: When an orifice plate is placed in a pipe carrying the fluid whose flow rate is to be measured, the orifice plate causes a pressure drop, between the converging of the fluid and diverging of the fluid, which varies with the flow rate. This pressure drop is measured using a differential pressure sensor and when calculated this pressure drop becomes a measure of flow rate.

28. How is flow measured using Venturimeter?

Ans: When a venturimeter is placed in a pipe carrying the fluid whose flow rate is to be measured, a pressure drop occurs between the entrance and throat of the venturimeter. This pressure drop is measured using a differential pressure sensor and when calculated this pressure drop becomes a measure of flow rate.

29. How is flow measured using Rotameter (Variable-area meter) ?

Ans: The increase in flow rate will make the float to rise higher and vice versa. That is, the position of the float becomes a direct indication of flow rate. (by noting the position of the float with respect to the graduations on the tapered tube).

30. How is flow measured using Pitot tube (Total pressure probe)?

Ans: The pitot tube is introduced in the fluid flow area. The differential pressure (Impact pressure – Static pressure) is measured using a differential pressure sensor. This differential pressure becomes a measure of flow rate at that point where the pitot tube is present in the flowing fluid.

31. State the differences between Venturimeter and Orificemeter.

Ans:

S.No.	Venturimeter	Orificemeter
1.	Loss of head is low.	Loss of head is high.
2.	Initial cost is more.	Low initial cost.
3.	No wear and tear.	More wear and tear.
4.	Requires more space.	Requires less space.
5.	Difficult to install and replace.	Ease of installation and replacement.

32. Give the principle of hot wire anemometer.

Ans: When a fluid flows over a heated surface, heat is transferred from the surface, and so its temperature

reduces. The rate of reduction of temperature is related to flow rate.

33. List the devices used for temperature measurement.

Ans: * Bimetallic strip thermometers * Pressure thermometers* Thermistors *Pyrometers and* Thermocouples.

34. What is a bimetallic strip? Name its types.

Ans: A bimetallic strip is made of two thin strips of metal which have different thermal co-efficients of expansion. The two metal strips are joined together by brazing, welding or riveting so that the relative motion between them is arrested. Different common forms of bimetallic sensors are: * Helix type * Spiral type * Cantilever type and * Flat type.

35. Name the metals used in Bimetallic strips.

Ans: High expansion material - * Brass* Nickel-iron alloys with chromium and manganese.

Low expansion material - * Invar (alloy of nickel and iron)

36. What are the important properties a material should have to be selected for bimetallic thermometers?

Ans: The following properties should be high:

* Co-efficient of expansion * Modulus of elasticity * Elastic limit after cold rolling

* Electrical conductivity * Ductility and * Metallurgical ability.

37. State the two principles on which Bimetallic thermometers work.

Ans: * All metals change in dimension, i.e. expand or contract when there is a change in temperature.

* The rate at which this expansion or contraction takes place depend on the thermal co-efficient of expansion of the metal and this thermal co-efficient of expansion is different for different metals. Hence the difference in thermal expansion rates is used to produce deflections which are proportional to temperature changes.

38. How is temperature measured using pressure thermometer?

Ans: When a liquid, gas or vapour filled system is subjected to a temperature change, the volume of the liquid, gas or vapour changes causing a pressure difference in the filled system. This pressure difference becomes an indication of temperature changes when calibrated.

39. What is the principle used in thermocouples? (or) What is “Principle of thermo electricity”? (or) What is seebeck effect?

Ans: The principle states that “ When two conductors of two different metals A and B are joined together at one

end to form a junction, and this junction is heated to a higher temperature with respect to the free ends, a voltage is developed at the free ends and if these two conductors of metals at the free ends are connected, then the emf setup will establish a flow of current".

40. State " Law of intermediate metals " in thermocouples.

Ans: In a circuit consisting of two dissimilar homogeneous metals having the junctions at different temperatures, the emf developed will not be affected when a third homogeneous metal is made a part of the circuit, provided the temperature of its two junctions are the same.

41. State " Law of intermediate temperatures " in thermocouples.

Ans: The thermal emf produced when a circuit of two homogeneous metals exists between a first temperature and a second and thermal emf produced when the same circuit exists between the second temperature and a third are algebraically equal to the thermal emf produced when the circuit exists between first and third temperatures.

42. What is the principle involved in fluid expansion thermometer?

Ans: In fluid expansion thermometer, the change in pressure in the bulb is taken as an indication of the temperature.

43. What are the physical characteristics of temperature measuring sensor?

Ans: Resistance Temperature Detectors are the sensors used to measure the temperature by correlating the resistance of the RTD element with temperature.

44. State the differences between resistance thermometers and Thermistors.

Ans:

S.No.	Resistance Thermometers	Thermistors
1.	Resistance change with temperature shift is small and positive.	Resistance change with temperature shift is large and negative.
2.	Provides a linear temperature - resistance relation.	Provides a non linear temperature - resistance relation.
3.	Operating temperature range is - 250 to 1000°C	Operating temperature range is - Log to 275°C
4.	More time stable.	Not time stable.

45. Write The Principle Of Temperature Measurement Using themocouple?

Ans: When two metals are joined together it will create an emf and it is primarily a function of the junction temperature.

46. What is Kentometer?

Ans: It is a device for measurement of absolute pressure.

47. What is thermopile?

Ans: When thermocouples are connected in series it is called thermopile.

48. What are the types of pyrometers?

Ans: i) Optical pyrometers ii) Total radiation pyrometer iii) Infrared pyrometer.

49. What are the applications of bimetallic strips?

Ans: i) Simple ON/OFF switches ii) Control switches.

50. List some of the disadvantages of bimetallic thermometers.

Ans: i) Possibility of calibration change due to rough handling. ii) Limitation to local maintenance. iii) Availability of indication type only.

51. What are the advantages of filled system thermometer?

Ans: i) Low cost ii) Less maintenance requirement iii) Rugged construction iv) Absence of need of electric power.

52. Explain the principle of operation of Thermistor.

Ans: They have negative temperature coefficient of resistance. i.e. With increase in temperature, the resistance decreases and vice-versa.

53. What is the purpose of protecting tube in a Thermocouple?

Ans: It is used to protect the thermocouple from harmful atmosphere and corrosive fluids.

54. What are the physical characteristics of temperature measuring sensor?

Ans: 1. Liquid Thermometer - Expansion of the fluid.

2. Thermocouple Thermometer - Thermoelectric effect (Seebeck effect)

3. Metal resistance Thermometer - Resistance is temperature dependent. They have a positive temperature coefficient.

4. Semiconductor thermometer - 2 types of sensors such as negative temperature coefficient (NTC) and Positive temperature coefficient (PTC)

55. Classify the types of strain gauges.

Ans: i) Unbonded strain gauge ii) Bonded strain gauge iii) Fine wire strain gauge iv) Metal foil strain gauge v) Piezo resistive strain gauge.

56. Mention the need for strain gauge in wheatstone network circuits.

Ans: The change in resistance due to strain in the gauges can be measured or made to give an output which can be easily displayed or recorded.

57. Outline the advantages to be gained by the use of electrical resistance strain gauge factor device in both static and dynamic condition.
Ans: i) High sensitivity ii) Great stability iii) Comparative ruggedness iv) Ease of application.
58. Mention a few materials used in bonding of strain gauges.
Ans: i) Ceramic cement ii) Epoxy iii) Nitrocellulose.

PART – B QUESTIONS

1. How to measure the power by using rope brake dynamometer? Explain with a neat diagram.
2. Explain how cup and vane type anemometers are used to measure air movement.
3. With neat sketch explain the construction and working principle of vapour pressure thermometer.
4. List the advantages of temperature measurement by using the resistance thermometer.
5. Explain with neat diagram the purpose and operating principle of a venturimeter.
6. Explain the working principle of an electrical resistance thermometer.
7. With neat sketch explain the working principle of thermocouple and bimetallic strip. State its applications.
8. With neat sketch explain the working principle of rotameter and pitot tube. State its applications.

ME6505 DYNAMICS OF MACHINES

ME6505 DYNAMICS OF MACHINES SYLLABUS REGULATION 2013

UNIT I FORCE ANALYSIS

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses-Dynamics of Camfollower mechanism.

UNIT II BALANCING

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

UNIT III SINGLE DEGREE FREE VIBRATION

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration – Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION

Response of one degree freedom systems to periodic forcing – Harmonic disturbances –Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

UNIT V MECHANISM FOR CONTROL

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

Text Book(s):

T 1: Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 3rd Edition, Oxford University Press, 2009.

T 2: Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw-Hill, 2009.

Reference Book(s):

1. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
2. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2005
3. Benson H. Tongue, ”Principles of Vibrations”, Oxford University Press, 2nd Edition, 2007
4. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
5. Allen S. Hall Jr., “Kinematics and Linkage Design”, Prentice Hall, 1961
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COURSE OUTCOMES

CO1	Calculate the inertia forces in reciprocating and rotating masses and turning moments in flywheels for I.C Engines and Punch presses.
CO2	Balance reciprocating and rotating masses and Balancing machines , Field Balancing
CO3	Analyse longitudinal. Transverse and Torsional Free vibration
CO4	Formulate the solutions for forced vibration response to Harmonic and periodic excitation
CO5	Maintain equilibrium speed using governors.
CO6	Appreciate the gyroscopic effect in mechanical applications

CO Nos.		**Level of correlation* of the COs with the relevant POs/PSOs**						
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 6**	**PO 12**	**PS O1**	**PS O2**
CO 1	3	3	2	1	-	-	**3**	-
CO 2	3	2	1	1	-	-	**3**	-
CO 3	3	2	1	1	-	-	**3**	-
CO 4	3	2	1	1	-	-	**3**	-

CO 5	3	2	1	1	**-**	**-**	**3**	**-**
CO 6	3	2	1	1	**-**	**-**	**3**	**-**

ME 6505- DYNAMICS OF MACHINES
UNIT 1- FORCE ANALYSIS

2 Marks:

1. Define static force analysis with an example.

- If components of a machine accelerate, inertia will be produced due to their masses.
- But, if the magnitudes of these forces are small compared to the externally applied forces then the inertia produced by the components can be neglected. Such an analysis is called Static force analysis.
- Example: In hydraulic lifting cranes, the magnitude of inertia force due to the weight of the hoisting hook is small compared to the externally applied loads and hence the inertia force due to the weight of the hook can be neglected.

2. Define dynamic force analysis with an example.

- If components of a machine accelerate, inertia will be produced due to their masses.
- If the inertia effect due to the mass of the component is also considered, it is called as dynamic force analysis.
- Example: In case of IC engines, which rotate at high speed, even the slightest eccentricity at the centre of mass from the axis of rotation causes very high magnitude of dynamic forces.

3. **What do you mean by inertia?** *(Nov/Dec 2016)*

The property of matter offering resistance to any change of its state of rest or of uniform motion in a straight line is known as inertia.

4. **Define inertia force and Inertia torque?** *(Nov/Dec 2016; Apr/May 2004)*

The inertia force is an imaginary force, which when acts upon a rigid body, brings it in an equilibrium position.

$$\text{Inertia force} = - \text{Acceleration force} = - m.a$$

The inertia torque is an imaginary torque, which when applied upon the rigid body, brings it in equilibrium position. It is equal to the acceleration couple in magnitude but opposite in direction.

$$\text{Inertia torque or couple} = - I.\alpha$$

5. **State D' Alembert's principle?** *(May/June 2016; Nov/Dec 2007; Nov/Dec 2006; Nov/Dec 2003; Apr/May 2003)*

D' Alembert's principle states that the inertia forces and torques, and the external forces and torques acting on a body together result in statically equilibrium.

$$F + (-m.\ a) = 0 \text{ and } T + (-I.\ \alpha) = 0.$$

6. State the principle of superposition?

The principle of superposition states that for linear systems the individual responses to several disturbances or driving functions can be superposed on each other to obtain the total response of the system.

7. **What are the conditions for a body to be in static and dynamic equilibrium?** *(May/June 2016; Nov/Dec 2007; May/June 2006; Nov/Dec 2005; Apr/May 2004)*

a. Vector sum of all the forces acting on a body is zero. ($\sum F = 0$)

b. Vector sum of the moments of all forces acting about any arbitrary point or axis is zero. ($\sum M = 0$)

First condition is sufficient for static equilibrium together with second condition is required for dynamic equilibrium.

8. **What is a free body diagram?** *(Apr/May 2005)*

It is a sketch or drawing of the body, isolated from the rest of the machine and its surroundings, upon which the forces and moments are shown in action. (give example)

9. **Define piston effort?** *(Apr/May 2017; May/June 2016)*

Piston effort is defined as the net or effective force applied on the piston, along the line of stroke. It is also known as effective driving force (or) net load on the gudgeon pin.

10. **Define crank effort and crank-pin effort?** *(May/June 2016; Nov/Dec 2007; Nov/Dec 2006)*

Crank effort is the net effort (force) applied at the crank pin perpendicular to the crank, which gives the required turning moment on the crankshaft.

The component of force acting along the connecting rod (F_Q) perpendicular to the crank is known as crank-pin effort.

11. What do you mean by correction couple or error in torque?

The error in torque (T_C) is given by $T_C = ml_1(l - L)\alpha$

This couple must be applied, when the masses are placed arbitrarily to make the system dynamically equivalent.

12. What is meant by turning moment diagram or crank effort diagram?

It is the graphical representation of the turning moment or crank effort for various position of the crank. In turning moment diagram, the turning moment is taken as the ordinate (Y-axis) and crank angle as abscissa (X-axis).

13. Explain the term maximum fluctuation of energy in flywheel? *(Nov/Dec 2003)*

The different between the maximum and the minimum energies is known as maximum fluctuation of energy.

ΔE = Maximum energy – Minimum energy

14. Define coefficient of fluctuation of energy. *(A. U. May/June 2006; Nov/Dec 2006)*

It is the ratio of maximum fluctuation of energy to the work done per cycle.

Maximum fluctuation of energy (ΔE)

$$C_E = \frac{Maximum\ Fluctuation\ of\ energy\ (\Delta E)}{Work done\ per\ cycle}$$

15. What is meant by maximum fluctuation of speed?

The difference between the maximum and minimum speeds during a cycle is called maximum fluctuation of speed.

16. Define coefficient of fluctuation of speed? *(Nov/Dec 2006; May/June 2006)*

The ratio of the maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation of speed (C_S).

$$C_s = \frac{N_1 - N_2}{N} = \frac{2(N_1 - N_2)}{N_1 + N_2}$$

Where,

N_1 = Maximum speed

N_2 = Minimum speed, and

$N = \frac{N1+N2}{2}$

17. Define coefficient of steadiness?

The reciprocal of the coefficient of fluctuation of speed is known as coefficient of steadiness (m)

$$m = \frac{1}{C_s} = \frac{N}{N_1 - N_2}$$

18. List out few machines in which fly wheel is used?

Fly wheels used in:

a) Punching machines, b) Shearing machines,

c) Rivetting machines, and d) Crushing machines.

19. Why flywheels are needed in forging and pressing operations? *(Nov/Dec 2016; Nov/Dec 2006; Apr/May 2005)*

In both forging and pressing operations, flywheels are required to control the variations in speed during each cycle of an engine.

20. What is cam dynamics?

Cam dynamics is the study of cam follower system with considering the dynamic forces and torques developed in it.

21. Define unbalance and spring surge? *(Apr/May 2003)*

Unbalance: A disc cam produces unbalance because its mass is not symmetrical with the axis of rotation.

Spring surge: Spring surge means vibration of the retaining spring.

22. Define windup. What is the remedy for camshaft windup? *(Nov/Dec 2003)*

Twisting effect produced in the camshaft during the raise of heavy load follower is called as windup.

Camshaft windup can be prevented to a large extend by mounting the flywheel as close as possible to the cam.

Part B questions:

1. For reciprocating engine, derive the expression for
   I. Velocity and acceleration of the piston
   II. Angular velocity and angular acceleration of the connecting rod.

2. In a reciprocating engine mechanism, if the crank and connecting rod are 300mm and 1m long respectively and the crank rotates at a constant speed of 200r.p.m. Determine analytically,
   I. The crank angle at which the maximum velocity occurs and
   II. Maximum velocity of piston.
   III. Derive the relevant equations.

3. (i) Deduce the expression for the inertia force in the reciprocating force neglecting the weight of the connecting rod.

(ii) A vertical petrol engine with cylinder of 150mm diameter and 200mm strokes has a connecting rod of 350mm long. The mass is 1.6kg and the engine speed is 1800 rpm. On the expansion stroke with crank angle 30˚ from TDC, the gas pressure is 750KPa. Determine the net thrust on the piston.

4. (i) Define coefficient of fluctuation of speed and coefficient of fluctuation of energy.

(ii)The radius of gyration of a fly wheel is 1meter and fluctuation of speed is not to exceed 1% of the mean speed of the flywheel. If the mass of the flywheel is 3340kg and the steam develops 150KW at 135rpm, then find,

a) Maximum fluctuation of energy 2. Coefficient of fluctuation of energy

5. The length of crank and connecting rod of a horizontal reciprocating engine are 100mm and 500mm respectively. The crank is rotating at 400rpm. When the crank has turned 30˚ from the IDC, find analytically,

I. Velocity of piston
II. Acceleration of piston
III. Angular velocity of connecting rod
IV. Angular acceleration of connecting rod.

6. The length and connecting rod of a horizontal reciprocating engine are 200mm and 1meter respectively. The crank is rotating at 400rpm.When the crank has turned 30˚ from the inner dead center, the difference of pressure between cover end and piston rod is 0.4 N/mm^2. If the mass of the reciprocating parts is 100Kg and a cylinder bore is 0.4meters. Calculate

(i) Inertia force (ii) Force on piston (iii) Piston effort (iv) Thrust on the side of the cylinder walls (v) Thrust in the connecting rod (vi) Crank effort.

7. A horizontal gas engine running at 210rpm has a bore of 220mm and a stroke of 440mm. The connecting rod is 924mm long the reciprocating parts weight 20kg.When the crank has turned through an angle of 30˚ from IDC, the gas pressure on the cover and the crank sides are 500KN/m2 and 60KN/m2 respectively. Diameter of the piston rod is 40mm. Determine,

(i) Turning moment on the crank shaft
(ii) Thrust on bearing
(iii) Acceleration of the flywheel which has a mass of 8kg and radius of gyration of 600mm while the power of the engine is 22KW.

8. A single cylinder vertical engine has a bore of 300mm and a stroke of 400mm. The connecting rod is 1000mm long. The mass of the reciprocating parts is 140kg. On the expansion stroke with the crank at 30˚from the top dead center, the gas pressure is 0.7MPa.If the runs at 250rpm, determine;

(i) Net force acting on the piston
(ii) Resultant load on the gudgeon pin

(iii) Thrust on cylinder walls

(iv) The speed above which other things remaining same, gudgeon pin loads would be reversed in direction.

9. A vertical double acting steam engine has a cylinder 300mm diameter and 450mm stroke and runs at 200rpm. The reciprocating parts has a mass of 225kg and the piston rod is 50mm diameter. The connecting rod is 1.2m long. When the crank has turned 125˚ from IDC the steam pressure above the piston is 30KN/m^2. Calculate,

(i) Crank-pin effort

(ii) The effective turning moment on the crank shaft.

10. The turning moment diagram for a petrol engine is drawn to a scale of 1mm to 6N-9-9m and the horizontal scale of 1mm to 1˚. The turning moment repeat itself after every half revolution of the engine. The area above and below the mean torque line are 305, 710, 50,350,980 and 275mm^2. The mass of rotating parts is 40kg at a radius of gyration of 140mm.Clculate the coefficient of fluctuation of speed if the mean speed is 1500rpm.

11. The torque delivered by a two stroke engine is represented by T= (1000+300sin2θ-500cos2θ) N-m where θ is the angle turned by the crank from the IDC. The engine speed is 250rpm.The mass of the flywheel is 400kg and radius of gyration 400mm. Determine,

(i) the power developed

(ii) the total percentage fluctuation of speed

(iii) the angular acceleration of flywheel when the crank has rotated through an angle of 60˚ from the IDC

(iv) the maximum angular acceleration and retardation of the flywheel.

UNIT 2- BALANCING

2 Marks

1. **Write the importance of balancing?** *(May/June 2016)*

If the moving part of a machine are not balanced completely then the inertia forces are set up which may

cause excessive noise, vibration, wear and tear of the system. So the balancing of machine is necessary.

2. Write the different types of balancing.

- Balancing of rotating masses
  - Static Balancing
  - Dynamic balancing
- Balancing of reciprocating masses.

3. **Why balancing of dynamic forces are necessary?** *(Apr/May 2017; Nov/Dec 2006; Apr/May 2005)*

If dynamic forces are not balanced, they will cause worse effects such as wear and tear on bearings and excessive vibrations on machines. It is very common in cam shafts, steam turbine rotors, engine crank shafts and centrifugal pumps etc.

4. Define static balancing.

A system of rotating masses is said to be in static balance if the combined mass centre of the system lies on the axis of rotation.

5. State the condition for static balancing.

The net dynamic force acting on the shaft is equal to zero. This requires that the line of action of their centrifugal forces must be same.

6. **Dynamic balancing implies static balancing. Justify.** *(May/June 2016; Nov/Dec 2007; Nov/Dec 2003)*

Condition for dynamic balancing are

- The net dynamic force acting on the shaft is equal to zero. This is the condition for static balancing.
- The net couple due to dynamic forces acting on the shaft is zero.

From the above it is understood that dynamically balanced system must be initially statically balanced one.

7. Can a single cylinder engine be fully balanced? Why?

No, a single cylinder engine cannot be fully balanced. This is because of the unbalanced forces due to reciprocating

masses (i.e., m ω^2 r cosθ and m ω^2 r $\frac{\cos 2\theta}{n}$) remains constant in direction but varies in magnitude (because of variation in θ)

8. Define Dalby's method of balancing masses.

Dalby's method is used for balancing several masses rotating in different planes. In this method several forces acting on several planes are transferred to a single reference plane.

9. Write the phenomenon of transferring forces from one plane to another.

Transferring a force (F) from one plane to another plane having a distance 'l' is equivalent to transfer of same force 'F' in magnitude and direction in the reference plane is accompanied by a couple of magnitude 'Fl'.

10. Whether grinding wheels are balanced or not. If so Why?

Yes. The grinding wheels are properly balanced by inserting some low density materials. If not the required surface finish won't be obtained and the vibration will cause much noise.

11. Why complete balancing is not possible in reciprocating masses? *(May/June 2006; Nov/Dec 2004; Apr/May 2004)*

Balancing of reciprocating masses is done by introducing the balancing mass opposite to the crank. The vertical component of the dynamic force of this balancing mass gives rise to hammer blow. In order to reduce hammer blow, a part of the reciprocating mass is balanced. Hence complete balancing is not possible.

12. What are the various cases of balancing revolving masses?

- Balancing of single rotating mass by a single mass rotating in the same plane.
- Balancing of single rotating mass by a two masses rotating in the different plane.

- Balancing of several rotating masses in single plane.
- Balancing of several rotating masses in different plane.

13. Why cranks of a locomotive are generally at right angles to one another? *(Nov/Dec 2006)*

In order to facilitate the starting of locomotive in any position the cranks of a locomotive are generally at right angles to one another.

14. What are the effects of unbalanced primary force along the line of stroke of two cylinder locomotive?

- Variation in tractive force along the line of stroke
- Swaying couple.

15. Define tractive force.

The resultant unbalanced force due to the 2 cylinders along the line of stroke, is known as tractive force.

16. Define swaying couple. *(Nov/Dec 2007; Nov/Dec 2006; Apr/May 2005)*

The unbalanced force acting at a distance between the line of stroke of 2 cylinders constitute a couple in the horizontal direction. This couple is called as swaying couple.

17. **What is the effect of hammer blow and what is the cause it?** *(Apr/May 2017; Nov/Dec 2016; Apr/May 2004)*

The effect of hammer blow is to cause the variation in pressure between the wheel and the rail, such that vehicle vibrates vigorously. Hammer blow is caused due to the effect of unbalanced primary force acting perpendicular to the line of stroke.

18. What are in-line engines?

Multi-cylinder engines with the cylinder centre lines in the same plane and on the same side of the centre line of the crankshaft are known as in-line engine.

19. Give the reason for selecting different firing orders.

In multi cylinder engines there are several possibilities of the order in which firing takes place. To overcome the problems of vibration, fuel distribution, exhaust distribution etc. the designers select different firing orders.

20. Why radial engines are preferred?

In radial engines the connecting rods are connected to a common crank and hence the plane of rotation of the various cranks is same, therefore there are no unbalanced primary or secondary couples. Hence radial engines are preferred.

Part B questions

1. A shaft is rotating at a uniform angular speed. Four masses M1, M2, and M3and M4 of magnitudes 300kg, 450kg, 360kg, 390kg respectively are attached rigidly to the shaft. The masses are rotating in the same plane. The corresponding radii of rotation are 200mm, 150mm, 250mm and 300mm respectively. The angle made by these masses with horizontal are 0°.45°, 120°and 255°respectively.

Find,

I. the magnitude of balancing mass

II. the position of balancing mass if its radius of rotation is 200mm.

2. Four masses M1, M2, M3, and M4 are 200kg, 300kg, 240kg and 260kg respectively. The corresponding radii of rotation are 0.2m, 0.15m, 0.25m and 0.3m respectively and the angle between successive masses 45°, 75°and 135°. Find the position and magnitude of balance mass required if its radius of rotation is 0.25m.

3. The data for three rotating masses are given below:-

M1=4kg r1=75mm θ1=45
M2=3kg r2=85mm θ2=135
M3=2.5kg r3=50mm θ3=240

Determine the amount of counter mass at a radial distance of 65mm required for their static balance.

4. Four masses A, B, C, and D are completely balanced masses C and D makes angles of 90° and 195°

respectively with B in the same sense. The rotating masses have the following properties:

mA=25kg rA=150mm
mB=40kg rB=200mm
mC=35kg rC=100mm
rD=180mm

Planes B and C are 250mm apart.

Determine

i. the mass A and its angular position
ii. the position of planes A and D.

5. A, B, C and D are four masses carried by a rotating shaft at radii 100mm,125mm,200mm and 150mm respectively. The planes in which the masses revolve are spaced 600mm apart and the masses of B, C and D are 10kg, 5kg and 4kg respectively. Find the required mass A and relative angular setting of the four masses so that the shaft be in complete balance.

6. Four masses A, B, C and D revolves at equal radii and equally spaced along a shaft. The mass B is 7kg and the radii of C and D make angle s of 90° and 240 °respectively with the radius of B. Find the magnitude of masses A, C and D and angular position of A . So that the system may be completely balanced.

7. A shaft caries four rotating masses A, B, C and D which are completely balanced. The masses B, C and D are 50kg, 80kg and 70kg respectively. The masses C and D make angles of 90° and 195° respectively with mass B in the same sense. The masses A,B,C and D are concentrated at radius 75mm,100mm,50mm and 90mmrespectively.The plane of rotation of masses B and C are 250mm apart. Determine

I. the magnitude of mass A and its angular position
II. the position of planes A and D.

8. A four cylinder vertical engine has cranks 150mm long. The plane of rotation of the first, second and fourth cranks are 400mm,200mm and 200mm respectively from that of the third crank and their reciprocating masses are 50kg, 60kg and 50kg respectively. Find the mass of the reciprocating parts for the third cylinder and relative angular position of the cranks in order that the engine may be in complete balance.

9. A four cylinder vertical engine has cranks 300mm long. The plane of rotation of the first, third and fourth cranks are 750mm,1050mm and 1650mm respectively from that of the second crank and their reciprocating masses are 10kg, 400kg and 250kg respectively. Find the mass of the reciprocating parts for the second cylinder and relative angular position of the cranks in order that the engine may be in complete balance.

10. Derive the following expression of effects of partial balancing in two cylinder locomotive engine

I. Variation of tractive force
II. Swaying couple
III. Hammer blow

UNIT 3- FREE VIBRATIONS

2 Marks

1. **Define vibration.**

Any motion which repeats itself after as interval of time is called as vibration or oscillation. Therefore, vibration is a periodic motion.

At mean (or equilibrium) position, strain or potential energy + kinetic energy.

At extreme positions, kinetic energy – strain or potential energy.

2. **What are the different types of vibrations?** *(A. U. May/June 2016; May/June 2006; Apr/May 2003)*

- Free vibrations,
- Forced vibrations and
- Damped vibrations.

3. **Define the terms.** *(Apr/May 2003)*

I. Time period
II. Frequency

Time period (T): It is the time taken by a vibrating body to repeat the motion itself. Time period is usually expressed in seconds.

Frequency: The number of cycles completed in one second is called frequency. In S.I. units, frequency is expressed in hertz (Hz) or cycles per second (cps).

4. **Define free vibration.**

When a body is allowed to vibrate on its own, after giving it an initial displacement (disturbance), then the ensuring vibration is known as free or natural vibrations. No external force is applied on the body. The frequency of the free vibrations is called free or natural frequency and is denoted by f_n.
Eg: Tuning fork vibrations, Guitar string vibrations.

5. **Define forced vibration.**
When a body vibrates under the influence of an external force, then the ensuring vibration is known as forced vibrations. When an external force is applied, the body does not vibrate with its own natural frequency but vibrates with the same frequency of the applied external force. The external force is a periodic disturbing force created by unbalance.
Eg: Vibrations due to rotating and reciprocating masses of IC engines.

6. **Define damped vibration.** *(A. U. Nov/Dec 2016)*
When the amplitude of vibrations reduces in every cycle, then the vibration is known as damped vibration. This is because some amount of energy possessed by the vibrating system is dissipated (wasted) in overcoming the frictional resistances to the motion. Damping is provided by connecting 'dash pot'. When the dash pot is connected with free vibrating body to control vibrations, then it is called free damped vibrations and when it is connected with forced vibrating body to control vibrations, then it is called forced damped vibrations. The frequency of damped vibrations is called damped natural frequency and is denoted by f_d.

7. **Define degrees of freedom.** *(Nov/Dec 2007; Apr/May 2003)*
The number of independent coordinates required to specify completely the configuration of a system at any instant is called degrees of freedom.

8. **Define longitudinal vibration. Explain.**
When the particles of the shaft or disc move parallel to the axis of the shaft, then the ensuring vibrations are known

as longitudinal vibrations. In this case, the shaft elongates and contracts alternately. Due to this, tensile stress and

compressive stress are induced in the shaft alternately.

9. **Define stiffness of spring.**
It is defined as the force required to produce unit displacement in the direction of vibration. It is expressed in N/m.

10. **Define logarithmic decrement. Derive the equation.** *(A. U. May/June 2016; Nov/Dec 2016)*
It is defined as the natural logarithm of ratio of any two successive amplitudes of an underdamped system. It is represented by δ and it is a dimensionless quantity.

11. **Define hysteresis damping.**
The damping due to the internal friction of the molecules is called solid or structural damping. This damping occurs in all vibrating systems subject to elastic restoring forces. The amount of damping is small.

12. **Define damping coefficient.**
The damping force per unit velocity is as damping coefficient.

13. **The needles of electric meter are critically damped. Why?**
The needles of electric meter are critically damped so that they can return to its original position immediately after the reading is taken.

14. **Define transverse vibration.**
When the particles of the shaft or disc move approximately perpendicular to the axis of the shaft, then the ensuring vibrations are known as transverse vibrations. In this case, the shaft bends and straightens alternately. Due to this, bending stresses are induced in the shaft.

15. **Mention the two methods which are used to find the natural frequency of transverse vibration for a**

simply supported beam with several point loads. *(Nov/Dec 2005)*
(i) Energy method (ii) Dunkerley's method

16. **Define critical or whirling or whipping speed of shaft.** *(Nov/Dec 2007)*
It is the speed of a rotating shaft at which the shaft tends to vibrate violently in the transverse direction. It is dangerous to continue to run the shaft at its critical speed.

17. **Define torsional vibration.**
When the particles of the shaft or disc move in a circle about the axis of the shaft, then the ensuring vibrations are known as transverse vibrations. In this case, the shaft twists and untwists alternately. Due to this, shear stresses are induced in the shaft.

18. **Define torsional stiffness of shaft.**
It is defined as the torque required for unit angular displacement. Unit: Nm/rad.

19. **What is meant by torsionally equivalent shaft?**
It is one which has the same torsional stiffness as that of the actual shaft that it twists to the same extent under a given torque as that of actual shaft.

20. **What is meant by critical damping?** *(A. U. Apr/May 2017)*
The system is said to be critically damped when the damping force $\zeta = 1$. If the system is critically damped, the mass moves back very quickly to its equilibrium position within no time.

Part B questions

1. Derive an expression for the natural frequency of the free longitudinal vibration by
   a. Equilibrium method
   b. Energy method
   c. Rayleigh's method

2. In a single degree of damped vibration system a suspended mass of 8kg makes 30 oscillations in 18 seconds. The amplitude decreases in 18 seconds. The amplitude decreases to 0.25 of the initial value after 5 oscillations.

Determine (i) the spring stiffness (ii) logarithmic decrement (iii) damping factor (iv) damping coefficient.

3. Determine equation of motion when a liquid column vibrating in a 'U' tube by
(i) Newton's method (ii) Energy method and hence find its natural frequency.

4. (i) Deduce the expression for the free longitudinal vibration in terms of spring stiffness, its inertia effect and suspended mass.
(ii) A spring mass system has spring stiffness 's' N/m and has a mass of 'm'kg.It has the natural frequency of vibration as 12Hz. An extra 2kg mass is coupled to 'm' and natural frequency reduces by 2Hz.Find the value of 's' and 'm'.

5. A vibrating system consists of a mass of 8kg, spring of stiffness 5.6 N/m and dashpot of damping coefficient of 40 N/m/s. Find, (i) Critical damping coefficient (ii) the damping factor (iii) the natural frequency of damped vibration (iv) the logarithmic decrement (v) the ratio of two consecutive amplitude (vi) the number of cycle after which the original amplitude is reduced to 20 percent.

6. An instrument vibrates with a frequency of 1Hz when there is no damping. When the damping is provided, the frequency of damped vibration was observed to be 0.9Hz. Find, (i) damping factor (ii) logarithmic decrement.

7. Find the equation of notion for the spring mass-dashpot system for the cases when
(i) $\zeta = 2$ (ii) $\zeta = 1$ and (iii) $\zeta = 0.3$.
The mass 'm'is displaced by a distance of 30mm and released.

8. Between a solid mass of 0kg and the floor are kept two slabs of isolates, natural rubber and belt, in series. The natural rubber slab has a stiffness of 3000 N/m and equivalent viscous damping coefficient of 100 N-sec/m. The belt has a stiffness of 12000 N/m and equivalent viscous damping coefficient of 330 N-sec/m. Determine

undamped and the damped natural frequencies of the system in vertical direction.

9. (i) A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The young's modulus for the shaft material is 200 GN/m^2. Determine the frequency of longitudinal and transverse vibration of the shaft.

(ii) Explain the sketches different cases of damped vibrations.

10. The barrel of a large gun recoils against a spring on firing. At the end of the firing, a dashpot is engaged that allows the barrel to return to its original position in minimum time without oscillation. Gun barrel mass is 400 kg and initial velocity of recoils 1m. Determine spring stuffiness and critical damping coefficient of dashpot.

11. A steel shaft 100 mm in diameter is loaded and support in shaft bearing 0.4 m apart. The shaft carries three loads: first mass 12 kg at the centre, second mass 10 kg at a distance 0.12 m from the left bearing and third mass of 7 kg at a distance 0.09 m from the right bearing. Find the value of the critical speed by using Dunker ley's method. E=2X10^{11} N/m^2

UNIT 4- FORCED VIBRATIONS

2 Marks

1. A vibrating system consist of a mass of 7 kg and a spring stiffness 50 N/cm and damper of damping coefficient 0.36 Ncm^{-1} sec. Find the damping factor.

M= 7kg, s=50 N/cm, c= 0.36 Ncm^{-1} sec= 36N/m/sec

$\omega_n = \sqrt{(s/m)} = \sqrt{(5000/7)} = 26.72$ rad/sec

$c_c = 2m = 2x7x26.72 = 374.16$ N/m/s

Damping factor = c/ cc = 0.0962.

2. **What is the relationship between frequencies of undamped and damped vibrations?** $f_d/f_n = (\omega_d / 2\pi) / (\omega_n / 2\pi) = (\omega_d / \omega_n)$

3. **What is meant by transmissibility?**

When a machine is supported by a spring, the spring transmits the force applied on the machine to the fixed support or foundation. This is called as transmissibility.

4. **Define transmissibility ratio or isolation factor.**

The ratio of force transmitted (Ft) to the applied force (F) is known as transmissibility ratio.

5. **Briefly explain elastic suspension.**

When machine components are suspended from elastic members, the vibrational force produced by the machine components will not be transmitted to the foundation. This is elastic suspension.

6. **Specify any 2 industrial applications where the transmissibility effects of vibration are important.**

1. All machine tools 2. All turbo machines.

7. **Specify the importance of vibration isolation.**

When an unbalanced machine is installed on the foundation, it produces vibration in the foundation. So, in order to prevent these vibrations or to minimize the transmission of forces to the foundation, vibration isolation is important.

8. **What are the methods of isolating the vibration?**

I. High speed engines/machines mounted on foundation and supports cause vibrations of excessive amplitude because of the unbalanced forces. It can be minimized by providing spring damper.

II. The materials used for vibration isolation are rubber, felt cork etc. These are placed between the foundation and vibrating body.

9. **Define forced vibration.**

When the body vibrates under the influence of external force, then the body is said to be under forced vibrations.

10. **Give some examples of forced vibration.** *(Apr/May 2017)*

I. Ringing of electrical bell where the vibration is by means of electrical means.

II. The vibrations of air compressors, IC engines, machine tools and various other machinery.

11. **What are the various types of external forces that cause vibration?**

I. Periodic forces
II. Impulsive type forces
III. Random forces

12. **Define transient vibration.**
In real systems, the amplitude of vibration decays continuously because of natural damping and vanishes finally. Such vibration in real system is called transient vibration.

13. **Define magnification factor or dynamic magnifier.** *(May/June 2016; Nov/Dec 2007; Nov/Dec 2006; Nov/Dec 2004; Apr/May 2004; Nov/Dec 2003; Apr/May 2003)*
The ratio of the maximum displacement (X_{max}) to the static deflection under static force F_0 (x_0) is known as magnification factor.

$$X_{max} = M.F \times X_0$$

14. **Define frequency response curve.**
A curve between the magnification factor and frequency ratio ( ) is known as frequency response curve.

15. **What is phase response curve?**
A curve between phase angle (ϕ) and frequency ratio is known as phase frequency curve.

16. **What are the types of isolation?**
I. Force isolation
II. Motion isolation

17. **What is force isolation?**
Vibrations produced in unbalanced machines should be isolated from the foundation so that the adjoining structure is not set into vibrations. This type is force isolation.

18. **What is motion isolation?**
The unbalanced machines are isolated from their foundation so that there should not be any damage either to the machines or the foundation. This is motion isolation.

19. **Define force transmissibility.** *(May/June 2006; Apr/May 2005)*
It is defined as the ratio of the force transmitted FT (to the foundation) to the force applied on the F_0.

20. **Define logarithmic decrement.** *(Nov/Dec 2016; May/June 2016; Nov/Dec 2006; Nov/Dec 2004)*
Logarithmic decrement is defined as the natural logarithm of the amplitude reduction factor.

The amplitude reduction factor is the ratio of any two successive amplitudes on the same side of the mean position.

21. What is meant by harmonic forcing? *(Nov/Dec 2005; Apr/May 2005)*
The term harmonic forcing refers to a spring mass system with viscous damping, excited by a sinusoidal harmonic force.

22. **What is vibration isolation?** *(Apr/May 2017; Nov/Dec 2016; Nov/Dec 2007; May/June 2006; Apr/May 2005; Nov/Dec 2004)*
The term vibration isolation refers to the prevention or minimisation of vibrations and their transmission due to unbalanced machines.

Part B questions

1. A mass of 50 kg is supported by an elastic structure of total stiffness 20 KN/m. The damping ratio of the system is 0.2. A simple harmonic disturbing force acts on the mass and at any time 't' seconds, the force is 60 sin10t newtons. Find amplitude of the vibration and phase angle caused by the damping.

2. A mass of 50kg is supported by an elastic structure of total stiffness 20KN/m. The damping ratio of the system is 0.25.A simple harmonic disturbing force acts on the mass and at any time 't' seconds, the force is 75cos12t newtons. Find amplitude of the vibration and phase angle caused by the damping.

3. A mass of 10kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is10N/mm. The viscous damping causes the amplitude to decreases to one-tenth of the initial value in four complete oscillations. If a periodic force of 150cos50t N is applied at the mass in the vertical direction. Find the amplitude of the forced vibrations? What is its value of resonance?

4. A harmonic exiting force of 25N is acting on a machine part which is having a mass of 2Kg and vibrating

in viscous medium. The exciting force causes resonant amplitude of 12.5mm with a period of 0.2sec.

5. A body having a mass of 15kg is suspended from a spring which deflects 12mm under the weight of the mass. Determine the frequency of the free vibrations. What is the viscous damping force needed to make the motion a periodic at a speed of 1mm/s? If, when damped to this extend a disturbing force having a maximum value of 100N and vibrating at 6Hz is made to act on the body, determine the amplitude of the ultimate motion.

6. A single cylinder vertical petrol engine of total mass of 200kg is mounted upon a steel chassis frame. The vertical static deflection of the frame is 2.4mm due to the weight of the engine .The mass of the reciprocating parts is 18kg and stroke of piston 160mm with S.H.M. If dashpot of damping coefficient of 1N/mm/s used to damp the vibrations, calculate steady state (i) Amplitude of vibrations at 500rpm engine speed. (ii)The speed of the driving shaft at which resonance will occurs.

7. A vertical single stage air compressor having a mass of 500kg is mounted on spring having stiffness of 1.96X105N/m and dashpot with damping factor of 0.2m.The rotating parts are completely balanced and the equivalent reciprocating parts weight 20kg.The stroke is 0.2m.Determine the dynamic amplitude of vertical motion of the excitation force if the compressor is operate at 200rpm.

8. A machine 100kg has a 20kg rotor with 0.5mm eccentricity. The mounting spring have $s=85x10^3$. The operating speed is 600rpm and the unit is constrained to move vertically. Find (i) Dynamic amplitude of machine (ii) the force transmitted to the support.

9. A single cylinder engine has an out of balance force of 500N at an engine speed of 30rpm.The total mass of engine is 150kg and its carried on a set of total stiffness 300N/cm. (i) Find the amplitude of steady motion of the mass and maximum oscillating force transmitted to the foundation. (ii)If a viscous damping is interposed between the mass and the foundation the damping force 1000N at 1m/s of velocity, find the amplitude of force damped oscillation of the mass and its angle of lag with disturbing force.

10. An industrial machine weighting 445kg is supported on a spring with a statical deflection of 0.5cm.If the machine has rotating imbalance of 25kg-cm.Determine the force transmitted at 1200rpm and the dynamic amplitude at the speed.

11. The mass of an electric motor is 120kg and it runs at 1500rpm.The armature mass is 35kg and its centre of gravity lies 0.5mm from axis of rotation. The motor is mounted on five springs of negligible damping. So that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally distributed among the five springs. Determine (i) the stiffness of the spring (ii) the dynamic force transmitted to the base at the operating speed. (iii) Natural frequency of system.

UNIT 5- MECHANISMS FOR CONTROL

2 Marks

1. Explain the function of governors. *(Apr/May 2005; Apr/May 2003)*

The function of a governor is to maintain the speed of an engine within specified limits whenever there is a variation of load. Governors control the throttle valve and hence the fuel supply to cater the load variations on engines.

2. What is the principle of working of centrifugal governors?

The centrifugal governors are based on balancing of centrifugal force on the rotating balls by an equal and opposite radial force.

3. Differentiate the functions of flywheel and governor. *(Apr/May 2003)*

S.No.	FLYWHEELS	GOVERNORS
1	The function of flywheel is to reduce the fluctuations of speed during a cycle above and below the mean value for constant load from the prime mover.	Its function is to control the mean speed over a period for output load variations.

2	It works continuously from cycle to cycle.	Its works intermittently i.e. only when there is change in the load.
3	It has no influence on mean speed of the prime mover.	It has no influence over cyclic speed fluctuations.

4. What is the principle of inertia governors?

In inertia governors, the balls are so arranged that the inertia forces caused by an angular acceleration or retardation of the shaft tend to alter their position.

5. What is equilibrium speed?

The speed at which the governor balls arms, sleeve etc, are in complete equilibrium and there is no upward or downward movement of the sleeve on the spindle is known as equilibrium speed.

6. Explain controlling force?

An equal and opposite force to the centrifugal force acting radially inwards (1.e. centripetal force) is termed as controlling force of a governor.

7. Explain governor effect? *(Apr/May 2017)*

The mean force acting on the sleeve for a given percentage change of speed for lift of the sleeve is known as governor effect.

8. Define power of governor.

The power of governor is the work done at the sleeve for a given percentage change of speed. It is the product of the mean value of the effort and the distance through which the sleeve moves.

Power = Mean effort X Lift of sleeve.

9. Explain sensitiveness of governors? *(Nov/Dec 2016; Nov/Dec 2006; Apr/May 2004)*

The sensitiveness is defines as the ratio of the mean speed to the difference between the maximum and minimum speeds.

Sensitiveness = N/N1 – N2 = 2(N1 + N2)/ (N1 – N2)

N1 – Max Speed : N2 – Min Speed

10. Define the coefficient of sensitiveness.

It is the ratio between range of speed and mean speed.

Coefficient of sensitiveness = Range of speed/mean Speed = N1 – N2 /N

11. What is meant by hunting? *(May/June 2016; Nov/Dec 2007; Nov/Dec 2006)*
The phenomenon of continuous fluctuation of the engine speed above and below the mean speed is termed as hunting. This occurs in over sensitive governors.

12. Explain the term stability of governor?
A governor is said to be stable if there is only one radius of rotation for all equilibrium speeds of the balls within the working range. If the equilibrium speed increases the radius of governor ball must also increase.

13. What is controlling force diagram?
When the graph is drawn between the controlling force as ordinate and radius of rotation of the balls as abscissa, the graph so obtained is called controlling force diagram.

14. What are the uses of controlling force diagram?
Controlling force diagram is used to examine the stability and sensitiveness of the governor and also shows the effect of friction on governor's performance.

15. Give the applications of gyroscopic couple.

I. In instrument or toy known as gyroscope.
II. In ships in order to minimize the rolling and pitching effects of waves.
III. In aeroplanes, monorail cars and gyro compass etc.

16. Define steering.
It is the turning of a complete ship in a curve towards left or right, while it moves forward.

17. Define pitching.
It is the movement of a complete ship up and down in a vertical plane about transverse axis.

18. Why there is no effect of the gyroscopic couple acting on the body of a ship during rolling? *(Nov/Dec 2007)*
We know that, for the effect of gyroscopic couple to occur, the axis of procession should always be perpendicular to the axis of the spin. In case of rolling of a ship, the axis of

precession is always parallel to the axis of spin for all positions. Hence there is no effect of the gyroscopic couple acting on a body of the ship during rolling.

19. Discuss the effect of the gyroscopic couple on a 2 wheeled vehicle when taking a turn.

The gyroscopic couple will act over the vehicle outwards. The tendency of this couple is to overturn the vehicle in outward direction.

20. Explain gyroscopic couple. *(Apr/May 2017; Nov/Dec 2007; May/June 2006; Nov/Dec 2005; Apr/May 2005; Apr/May 2004)*

If a body having moment of inertia I and rotating about its own axis at ω rad/s is also caused to turn at ω_p rad/s about an axis perpendicular to the axis of spin, then it experiences a gyroscopic couple of magnitude (1.ω. ω_p) in an axis which is perpendicular to both the axis of spin and axis of precession.

Part B questions

1. A porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball has a mass of 5kg and mass of the central load on the sleeve is 25kg.The radius of rotation of the ball is 150mm when governor is at maximum speed. Find the maximum and minimum speed and range of speed of the governor.

2. The length of the upper and lower arms of a porter governor are 200mm and 250mm respectively. Both the arms are pivoted on the axis of rotation. The central load is 150N, the weight of the each ball is 20N and the friction of the sleeve together with the resistance of the operating gear is equivalent to a force of 30N at the sleeve. If the limiting inclinations of the upper arms to the vertical are 30° and 40° taking friction in to account. Find the range of speed of the governor.

3. Calculate the rage of speed of a porter governor which has equal arms of each 200mm long and pivoted on the axis of rotation .The mass of each ball is 4kg and the central load of the sleeve is 20kg.The radius of rotation of the ball is 100mm when the governor being to lift and 130mm when the governor is at maximum speed.

4. A hartnell governor having a central sleeve spring and two right angled bell crank lever operates between 290rpm and 310rpm for a sleeve lift of 15mm.The sleeve and ball arms are 80mm and 120mm repectively.The levers are pivoted at 120mm from the governoraxis and mass of the ball is 2.5kg.The ball arms are parallel at lowest equilibrium speed. Determine (i) load on the spring at maximum and minimum speeds and (ii) Stiffness of the spring.

5. The controlling force in a spring controlled governor is 1500N when radius of rotation is 200mm and 887.5N when radius of rotation is 130mm.The mass of each ball is 8kg.If the controlling force curve is a straight line, then find (i) Controlling force at 150mm radius of rotation (ii) Speed of the governor at 150m radius (iii) increase in initial tension so that governor is isochronous. (iv) isochronous speed.

6. In a spring controlled governor, the controlling force curve is a straight line. When the balls are 400mm apart, the controlling force is 1200N and when 200mm apart, the controlling force is 450N.Determine the speed at which the governor runs when the balls are 250mm apart. When initial tension on the spring would be required for isochronisms and what would be the speed. Take mass of each ball to be 10kg.

7. Calculate the minimum speed of a proell governor, which has equal arms each of 200mm and are provided on the axis of rotation. The mass of each ball is 4kg and the central mass on the sleeve is 20kg.The extension arms of the lower links are each 60mm long and parallel to the axis when the minimum radius of the ball is 100mm.of load.

8. (i) Explain the effect of Gyroscopic couple on a Naval ship during pitching.
(ii) Explain the effect of Gyroscopic couple on an Aeroplane.

9. The rotor of a turbine yatch rotates at 1200rpm clockwise when viewed from stern. The rotor has a mass of 750 kg and radius of gyration of 250mm. Find the maximum gyroscopic couple transmitted tothe hull when yacht pitches with a maximum angular velocity of 1 rad/s. What is the effect of this couple?

10. The turbine rotor of a ship has a mass of 20 tonnes and a radius of gyration 0.75.Its speed is 2000rpm.The ship pitches 6° above and below the horizontal position .One complete oscillation takes 18 seconds and the motion is simple harmonic. Determine (i) the maximum couple tending to shear the holding down bolt of the turbine (ii)The maximum angular acceleration of the ship during pitching (iii) The direction in which the bow will tend to turn while, if the rotation of the rotor is clockwise when locking from rear.

GE6075 Professional Ethics in Engineering

GE6075 Professional Ethics in Engineering Syllabus

UNIT I	**HUMAN VALUES**	**10**
Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.		
UNIT II	**ENGINEERING ETHICS**	**9**
Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.		
UNIT III	**ENGINEERING AS SOCIAL EXPERIMENTATION**	**9**
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.		
UNIT IV	**SAFETY, RESPONSIBILITIES AND RIGHTS**	**9**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.		
UNIT V	**GLOBAL ISSUES**	**9**
Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.		

Text Book(s)

T 1: Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003).

T 2: Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

Reference Book(s)

R 1: Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
R 2: Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009 .
R 3: John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
R 4: Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
R 5: Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.
R 6: World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011

CO 1	Understand Morals, Values and Ethics and will be able to differentiate between each other and introduce Yoga and Meditation.
CO 2	Understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories.
CO 3	Understand various social issues, industrial standards, code of ethics and role of professional ethics in engineering.
CO 4	Understand the responsibilities of an engineer for safety and risk benefit analysis and also exercise his rights.
CO 5	Understand various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives.

CO Nos.		Level of correlation* of the COs with the relevant POs/PSOs						
	PO1	PO2	PO3	PO4	PO6	PO12	PSO1	PSO2
CO1	3	3	2	1	-	-	3	-
CO2	3	2	1	1	-	-	3	-
CO3	3	2	1	1	-	-	3	-
CO4	3	2	1	1	-	-	3	-
CO5	3	2	1	1	-	-	3	-
CO6	3	2	1	1	-	-	3	-

PART A

1. What are human values? (APR 2014)(APRIL 2015)
Values decide the standard of behavior. Some universally accepted values are freedom justice and equality. Other principles of values are love, care, honesty, integrity, self-respect.

2. What are ethical values? (MAY 2016)
Trustworthiness, respect, responsibility, fairness, caring is ethical values

3. Distinguish values from ethics and culture. (R-2008)
Values are mainly related to individuals and since they are related to justice, they remain the same for everyone. E.g. truth, honesty, empathy and self respect. Values do not change from individual to individual. Ethics is common to a group of individuals; the group may be religious or professional. Ethics is mostly based on some code or law and judgment of any action is based on code of conduct or law. Ethics change from individual to individual Culture commonly refers to conduct of a group. E.g. system of worship, marriage. It may differ from society to society, nation to nation or religion to religion.

4. What is integrity? (APRIL MAY 2007)
Integrity is the unity of character based on moral values. Consistency in attitudes, emotions and conduct in relations to morally justified actions and values are also the part of integrity of individual. It implies honesty, trustworthiness.

5. Define work ethics (APRIL 2014)
By one's work one cannot harm others. Any worker cannot escape accountability. Worker has the moral responsibility to see that no other person's right, private or freedom is impaired or transgressed.

6. What is service learning? (APRIL 2017)
Service learning tells that one has moral responsibility to increase the desirable effects and to decrease the harmful effects. Any service should increase the desirable result.

7. Mention some civic virtues?
Good citizen demand civic virtue. It is the principle of not harming the surroundings .it also includes living peacefully, respect for others, protecting the environment and being normally and ethically good.

8. Write short notes on caring and sharing.
Caring is the essence of moral life. Caring involves feelings, relationship, contends with other persons and protecting others and causing least damage to others. Sharing means sharing of feelings, ideas thoughts, resources and profits. Sharing is always mutually beneficial. Sharing morally acceptable feelings, resources and materials is a value.

9. Write notes on honesty. (NOV 2016)
Any human being should imbibe honesty-honesty in acts, honesty in speech and honesty in beliefs. Honesty is the fundamental virtue in human relationship even though in may be difficult to follow some times.

10. What is courage as a value?
Courage implies self-respect and governs confrontations with danger and risk. It isnot excessive rashes or cowardice, but it is the middle ground. Taking calculated risks and boldness in facing crises are the hallmarks of courage as a human value. It defines the mental make up of an individual in taking bold decisions even under adverse situations.

11. Define co-operation.
Co-operation means extending help to others, for a good cause. Co-operation may be through an idea, a suggestion, an assistance or physical work which extends to others for common benefit.

12. Define empathy.
Empathy means putting self in a position of someone else and thinking as the later and reasoning suitable action.

13. Define spirituality.
Spirituality raises a man above the materialistic world into a realm where he seeks peace and real happiness.

15. Define Compromise?
In a negative sense it means to undetermined integrity by violating one"s fundamental moral principles. In a positive sense, however, it means to settle differences bymutual

concessions or to reconcile conflicts through adjustments in attitude and conduct.

16. Give the two aspects of Honesty? (NOV 2016)
Truthfulness – meeting responsibilities concerning truth-telling. Trustworthiness –Meeting responsibilities concerning trust.

17. Differentiate Self-respect and Self-esteem?
Self-respect: It is a moral concept; refers to the virtue properly valuing oneself.
Self-esteem: It is a psychological concept; means having a positive attitude toward Oneself, even if the attitude is excessive or otherwise unwarranted.

18. What are Human values? Explain briefly.
Values are the rules by which we make decisions about right and wrong, should and shouldn't, good and bad. "Emotional beliefs in principles regarded as particularly favorable or important for the individual."

Types of Values: (a) Right conduct, (b) Peace (c) Truth, (d) Love, (e) Nonviolence.

19. Factors That Demonstrate a Strong Work Ethic:

- Integrity,
- Sense of Responsibility, Emphasis on Quality, Discipline, and
- Sense of Teamwork.

20. Five Characteristics of a Good Work Ethic:

Reliability, Dedication, Productivity, Cooperation, and Character

21. Explain CIVIC VIRTUE.
Civic virtues are the moral duties and rights, as a citizen of the village or the country or an integral part of the society and environment.
Civic virtues are divided into four categories:

1. Civic Knowledge
2. Self-Restraint
3. Self-Assertion
4. Self-Reliance

22. Explain Respect for others.

Respect is a positive feeling of admiration or deference for a person. Respect can be a specific feeling of regard for the actual qualities of the one respected. It can also be conduct in accord with a specific ethic of respect. Treating people with respect makes your world a nicer place to live in, whether it's at home, at school, or out in your community. Don't insult people or make fun of them.

23. Explain Living Peacefully.

To live peacefully, one should start install peace within (self). Charity begins at home. Then one can spread peace to family, organization where one works, and then to the world, including the environment. Only who are at peace can spread peace. You cannot gift an article which you do not possess. The essence of oriental philosophy is that one should not fight for peace. It is oxymoron. War or peace can be won only by peace, and not by wars! One should adopt the following means to live peacefully, in the world

24. Explain Stress Management.

Stress management refers to the wide spectrum of techniques and psychotherapies aimed at controlling a person's levels of stress, especially chronic stress, usually for the purpose of improving every day functioning. Stress is a normal psychological and physical reaction to the ever-increasing demands of life. Surveys show that many Americans experience challenges with stress at some point during the year.

25. Define spirituality? (Nov/Dec 15)

Spirituality raises a man above the materialistic world into a realm where he seeks peace and real happiness

26. Explain Self- Confidence, Character and Spirituality. (May/June 16)

Self- Confidence: Certainty in one's own capabilities, values, and goals. These people are usually positive thinking, flexible and willing to change. They respect others so much as they respect themselves. **Character**: To determine the ideals.

Spirituality: Spirituality is a way of living that emphasizes the constant awareness and recognition of the spiritual dimension (mind and its development) of nature and people, with a dynamic balance between the material development and the spiritual development.

27. What are the values? (May/June 16)

Values denote something's degree of importance, with the aim of determining what action of life is best to do or live or to describe the significance of different actions.

28. What are the qualities of a self-confident people? (Nov/Dec 15)

1. Ambitious 2. Self-Love **3.** Risk-takers **4.** Self-awareness **5.** Change agent

Part –B (16 marks)

1. Explain with suitable example the need of courage in maintaining honesty and character. April 2014
2. Explain with suitable example how the respect for others religious enhances the peaceful living.
3. April 2014
4. Explain the importance of self confidence and empathy in ethics. Nov 2015
5. Explain civic virtue and respect for others and also explain the importance of cooperation. Nov 2015
6. Explain the role of yoga and meditation in the field of professional excellence and stress management. Nov 2016 April 2017
7. Explain the importance of self confidence in engineering ethics. May 2016
8. Explain character and spirituality and their importance in engineering ethics. May 2016
9. Explain Integrity and honesty in ethics Nov 2016
10. Explain the scope and importance of professional ethics in engineering? April 2017

11. Explain with suitable examples of Moral values and ethics.

UNIT II
ENGINEERING ETHICS
PART A

1. Define moral Dilemma? (May/June 2012)

Dilemmas are certain kind of situations in which a difficult choice has to be made. Moral dilemmas can also be called moral problems. Moral Dilemmas have two or more folding„s - moral obligations, duties, rights, goods, or ideals come disagreement with each other.

2. What are the chief characteristics of a profession? (MAY/JUNE 2012)

Knowledge, Organization, Public Good

3. What is the significance of engineering ethics? (MAY/JUNE 2011)

An activity and an area of inquiry. Ethical problems, issues and controversy Set of beliefs, attitudes and habits. Morally correct.

4. What is engineering ethics? (MAY/JUNE 2011, MAY/JUNE 2014)

Study of the moral issues and decisions confronting individuals and organizations engaged in engineering / profession. Study of related questions about the moral ideals, character, policies and relationships of people and corporations involved in technological activity. Moral standards /values and system of morals.

5. What is meant by normative inquiry? (MAY/JUNE 2011)

Engineering ethics involves normative inquiry in order to aim at identifying and justifying the morally desirable norms or standards that ought to guide individuals or groups. Normative questions include what ought to be? and what is good?

6. What do you mean by ethical pluralism? (APRIL/MAY 2010)

Ethical pluralism is the view that there may be alternative moral perspectives that are reasonable,

but no one of which must be accepted completely by all rational and morally concerned persons.

7. Differentiate Moral and Ethics? (MAY/JUNE 2010)

Moral:

- Refers only to personal behavior.
- Refers to any aspect of human action.
- Social conventions about right or wrong conduct.

Ethics:

- Involves defining, analyzing, evaluating and resolving moral problems and
- Developing moral criteria to guide human behavior.
- Critical reflection on what one does and why one does it.
- Refers only to professional behavior.

8. State Rawls principles? (NOV/DEC2010)

Each person is entitled to the most extensive amount of liberty compatible with an equal amount for others.Differences in social power and economic benefits are justified only when they are likely to benefit everyone, including members of the most disadvantaged groups.

1. Write any three uses of ethical theories. (NOV/DEC2010, MAY/JUNE 2014

Ethical theories are very useful in understanding and resolving moral dilemmas. In estimating the professional obligations and ideals.Determine to what extent, the obligations can be exercised in a given situation.

2. What are the types of Theories about Morality/ Right action? (MAY/JUNE 2009)

- Virtue ethics – Virtues and vices
- Utilitarianism – Most good for the most people
- Duty ethics – Duties to respect people
- Rights ethics – Human rights

11. Explain Ethical Egoism (MAY/JUNE 2009)

It deals with self-interest. Each person is the best judge of their own self-interest and is responsible for maximizing their own interest. Egoism preaches

selfishness but morality should encourage love, compassion etc.

12. Differentiate Ethical Relativism and Ethical Egoism? (MAY/JUNE2008)

- Ethical egoism – the view that right action consist in producing one„s own good.
- Ethical relativism – the view that right action is merely what the law and customs of one„s society require.

13. Explain moral integrity? (MAY/JUNE2008)

Moral integrity is the strength of character on the basis of moral concern and moral values. Integrity is the bridge that links the responsibilities between personal life and professional carrier.

9. Explain profession and professionalism? (NOV/DEC 2008)

Profession is a job through which someone makes living.Professionalism covers comprehensively all areas of practice of a particular profession. It requires skills and responsibilities involved in engineering profession.

10. Give the importance of Lawrence Kohlberg's and Carol Gilligan's theory? (NOV/DEC 2008)

Kohlberg gives greater emphasis to recognizing rights and abstract universal rules. Gilligan Stresses the importance of maintaining personal relationships based onmutual caring.

16. What is consensus and controversy?

Consensus means agreement and controversy means disagreement. Both plays the vital roles while considering moral autonomy.

17. What is the relationship between moral autonomy and authority?

Moral' autonomy is exercised on the basis of moral concern for other people and recognition of good moral reasons. Authority provides the frame work inwhich learning can takes place in class room/work place.

18. What are the types of virtues?

- Self-direction – commitment, self-discipline, courage
- Public spirited – justice, generosity.
- Teamwork – cooperation, loyalty, respect for authority, leadership qualities.
- Proficiency- technical skill, creativity.

19. What are the cardinal virtues/ Chief Virtues?

Wisdom - courage –temperament –justice

20. What are the concepts of pre-conventional & conventional level in Gilligan's theory?

Carol Gilligan recast the theory of Kohlberg as follows.

- **Pre conventional level:** Desire to derive benefits for oneself. Right conduct is viewed in a selfish manner as solely what is good for oneself.
- **Conventional level**: Here the basic motive is willingness to sacrifice one's own interests and a strong desire to hurt other's interests. Mostly women are always willing to give up their personal interests in order to serve the needs of others.

21. Define Ethics. Mention some universally accepted ethical standards. (NOV/DEC 13)

"Ethics" as the "discipline dealing with what is good and bad and with moral duty and obligation," "a set of moral principles or value" or “a theory or system of moral values." Ethics assists individuals in deciding when an act is moral or immoral, right or wrong. Ethical Standard such as Focus on ethics, Corporate culture, Managerial

22. Define moral values with suitable Example. (NOV/DEC 2013),(APR/MAY2015)

Moral values are the standards of good and evil, which govern an individual’s behavior and choices. Individuals morals may derive from society and government,

religion, or self-Honesty, respect for others, loyalty, responsibility for personal actions, generosity and kindness are all examples of moral values.

23. What is meant by normative enquiry?(APRIL/MAY 2011)

Normative ethics an approach to ethics, that works from standards of right or good action. There are three types of normative theories: virtue theories, deontological theories, and teleological theories.

24. Define "Professionalism". (APRIL/MAY 2015)

Professionalism means behaving in an ethical manner while assuming and fulfilling your rightful responsibilities in every situation every time, without fail. To get a bit more granular, one can say that it means, in part, conducting your affairs in such a way as to engender trust and confidence in every aspect of your work.

25. Define Moral Autonomy (NOV/DEC2014)

Moral autonomy, usually traced back to Kant, is the capacity to deliberate and to give oneself the **moral** law, rather than merely heeding the injunctions of others. Personal **autonomy** is the capacity to decide for oneself and pursue a course of action in one's life, often regardless of any particular **moral** content.

PART-B

1. What are the stages of moral development according to Gilligan? Discuss **(8) (May/June 2012, (May/June 2014)**
2. Apply both kohlberg's theory and Gilligan's theory in Heinz dilemma and justify your arguments? (8)**(May/June2011,May/June2012, (May/June 2014), (Apr/May2015)(Nov/Dec 2014)**
3. What are the uses of ethical theories explain? (16) **(MAY/JUNE 2012)**
4. Explain
   a. Professional responsibility (4)
   b. Integrity and self-respect. (8)
   c. Utilitarianism (4) **(May/June 2011)**

5. Explain Kohlberg's theory in detail?(12)**(May/June2011) (Apr/May2015)**

6. What are the scopes of engineering ethics? **16) (May/June 2011)**

7. What are the different ethical theories available for right action, self-interest, duty Ethics**.**
(16)**(May/June 2010, (Nov/Dec 2013), (Apr/May2015)**

8. Discuss the different models of professional roles?(16) **(May/June 10)**

9. Highlight the importance of engineering ethics? (16) **(May/June 11)**

10. Write short notes on Moral autonomy(**Nov/Dec 2013)**

11. What are the general types of inquiries involved in engineering inspection? Explain in detail the specific virtues of professional responsibility **(May/June 2014, (Nov/Dec 2013), (Apr/May2015) (Nov/Dec 2014)**

12. Explain the vital role of consensus and controversy while considering moral autonomy in engineering ethics.**(May/June 2014)**

13. Name and describe the theories of action? (8 Marks) **(April 2017)**

14. Describe the role of self interest with some examples. (8 Marks) **(April 2017)**

15. Discuss Moral Dilemma and Moral Autonomy (16) **(Nov 2016)**

16. Explain detail about the senses of engineering ethics**. May 2016**

UNIT –III
ENGINEERING AS SOCIAL EXPERIMENTATION

PART A

1.What are the pros and cons of industrial standardization? (MAY/JUNE 2012)

- ✓ Accuracy in measurement, interchange ability, eases of handling.
- ✓ Prevention on of injury, death and loss of income or property.
- ✓ Fair value of price.
- ✓ Competence in carrying out tasks.
- ✓ Sound design, ease of communications.

2. What are the limitations of ethical code? (MAY/JUNE 2011)(NOV/DEC 2014)

Codes are restricted to general and vague wording.Codes can„t give a solution or method for solving the internal conf Codes cannot serve as the final moral authority for professional conduct.

3. Define ethical accountability?(MAY/JUNE 2011)

The inherent tendency of accepting moral responsibility for the actions of an individual and also the spontaneous willingness to subject himself to the moral scrutiny in an open-minded manner is called ethical accountability.

4. Name the aerospace ace experts and scientists who were associated with the Launching of challenger? (MAY/JUNE 2010)

Allan McDonald of Morton-Thiokol at Cape Kennedy, Arnold Thomson and Roger Bois joly who were the seal experts at Morton-Thiokol and engineering managers, Bob Lund and Joe Kil minster were the experts associated with the launching of challenger space program.

5. Name some of the important code of ethics published by engineering societies. (MAY/JUNE 2010)

- National society of professional Engineers
- Board of Ethical review.

- NSPE opinion of the Board of ethical review.
- American Association of Engineering societies(AAES).
- Institute of Electrical and Electronics Engineers (IEEE).

6. What was the primary reason that caused the failure of space shuttle program "challenger" (NOV/DEC 2010)

The consequent rupturing of O-ring that constitute the field joints due to extreme cold weather was the primary reason that resulted in the failure of challenger space shuttle.

7. What are the problems with the law in engineering?(NOV/DEC 2010)

- ✓ Minimal compliance
- ✓ Many laws are without enforce able sanctions.

8. How engineering could be regarded as preventive technology?(MAY/JUNE 2009)

As per the familiar proverb that "prevention is better than cure", the ultimate process of solving the scientific-based problems is not by curing alone, but effectively by the preventive measures. Such type of defensive measures to prevent scientific ills is called preventive technology.

9. What are the general features of morally responsible engineers?(MAY/JUNE 2009)

- Conscientiousness.
- Comprehensive
- perspective.
- Autonomy.
- Accountability.

11. What are the differences between engineering and standard experiments?

Engineering experimentation involves human subjects as control groups, unlike in the standard experimentation .The process of obtaining the informed consent from the human-engineering experimentation. Unlike in the scientific experiments, new knowledge is not gained in engineering experiment.

12. Differentiate scientific experiments and engineering projects?

Scientific experiments are conducted to gain new knowledge, while —engineering projects are experiments that are not necessarily designed to produce very much knowledge.

13. How Titanic tragedy be brought under engineering as social experimentation?

Failure in the far-sighted approach of not providing enough number of lifeboat sand non-availability of proper safe exits handled to the sinking of titanic ship that caused the death toll of 1522 persons on board . These in designing are the reasons for bringing titanic tragedy under engineering as social experimentation

14. Define the term moral autonomy.

The moral beliefs and attitudes of an individual with a committed action towards the specific principles and goals are called moral autonomy.

15. What are the uncertainties occur in the model designs?

- Model used for the design calculations.
- Exact characteristics of the materials purchased.
- Constancies of materials used for processing and fabrication.
- Nature of the pressure, the finished product will encounter.

16. What is meant by engineering as experimentation? (MAY/JUNE2014) (APR/MAY 2015)(NOV/DEC 2014)

Experimentation (Preliminary tests or Simulations) plays a vital role in the design of a product or process.

In all stages of converting a new engineering concept into a design likes,

A. first rough cut design,

B. usage of different types of materials and processes,

C. detailed design,

D. further stages of work design

17. State the importance of Ethics codes. (MAY/JUNE2014)

Engineers shall uphold and advance the integrity, honor, and dignity of the engineering profession by:

1. using their knowledge and skill for the enhancement of the human race;
2. being honest and impartial and serving with fidelity the public, their employers, and clients.
3. striving to increase the competence and prestige of the engineering profession.
4. supporting the professional and technical societies of their discipline

18. What are the senses of engineering ethics?(NOV/DEC 2013)

An activity and area of inquiry.

- Ethical problems, issues and controversies.
- Ethical problems, issues and controversies. o Particular set of beliefs, attitudes and habits.
- Morally correct.

19. Define Engineering Ethics.(NOV/DEC 2013)

5. Study of the moral issues and decisions confronting individuals and organizations Engaged in engineering / profession.
6. Study of related questions about the moral ideals, character, policies and relationships of people and corporations involved in technological activity.
7. Moral standards / values and system of morals

20. **List the advantages of industrial standards.(APR/MAY 2015)**

- ✓ Increased marketability
- ✓ Reduced operational expenses
- ✓ Better management control
- ✓ Increased customer satisfaction
- ✓ Improved internal communication

PART-B

1. What is meant by professional responsibility and discuss the theories about virtues? (May/June2012)
2. Explain a Balanced Outlook on Law (Nov/Dec2010)
3. Discuss the theories pertaining to moral autonomy with specific reference to consensus and controversy? (May/June 2011)
4. Where and how do moral problems arise in engineering? (May/June2009)
5. Discuss on the different roles played in the code of ethics set by professional societies?**(May/June 2012,May/June2011,Nov/Dec 2013)(Nov/Dec2014)**
6. Give justification on how the challenger disaster could have been avoided by engineers? **(Nov/Dec 2011/May/June 2012)**
7. How engineering project differ from standard experimentation? **(Nov/Dec 2013)**
8. Discuss on the different roles played in the code of ethics set by professional societies? **(Nov 2013)**
9. Explain Engineers as responsible Experimenters**. (Nov/Dec 2012) April 2016,Dec 2016, April 2017)**
10. Briefly discuss the space shuttle challenger accident. What is the ethical problem involved in this? **(May/June 2014) (Nov/Dec 2014)**
11. Discuss about Research ethics. ? **(May/June 2014) (Nov/Dec 2014)**
12. What is meant by informal consent when bringing an experimental product to the market? **(May/June 2014)**
13. How the ethical codes provide discipline among the engineers**?(May/June2014), (Apr/May2015) (Nov/Dec 2014)**
14. Explain the work ethics in detail. **(Nov/Dec 2013)**
15. Whom do you think should take public accountability for unsafe machine? From the Designer to the final promoter, identify the roles and responsibilities towards

safety and justify your views through a detailed case study. **(April/May 2012)**

16. Discuss briefly the role of industrial standards**.(April/May 2015)**

17. Discuss the ethical issues involved in challenger case study (**April/May 2015)**

18. Compare and contrast engineering experiments with standard experiments**.(Nov/Dec2014)**

UNIT-IV
SAFETY, RESPONSIBILITIES AND RIGHTS

PART A

2. What is conflict Interest?(MAY/JUNE 2012)

Types of Conflicts of interest

- Actual conflict of interest
- Potential conflict of interest
- Apparent conflict of interest
- Interest in other companies
- Moonlighting
- Insider information

3. What are the reasons for Risk-Benefit Analysis? (NOV/DEC 2011, NOV/DEC 2013))

i. Risk-benefit analysis is concerned with the advisability of undertaking a project.

ii. It helps in deciding which design has greater advantages.

iii. It assists the engineers to identify a particular designs cores higher with that of t h e another one

4. What are the safety measures an engineer must know before assessing a risk of any product?(MAY/JUNE 2009)

The factors are:

a. Does the engineer have the right data?
b. Is he satisfied with the present design?
c. How does he test the safety of a product?
d. How does he measure and weight he risks with benefits for a product.

5. Explain the two types of Risk? **(MAY/JUNE 2012)**

i. Personal Risk:

An individual, who is given sufficient information, will be in a position to Decide whether to take part in a risky activity or not. They are more ready to take on voluntary risks than in voluntary risks.

ii. Public Risks:

Risks and benefits to the public are more easily determined than to individuals, larger number of people is taken in to account .Involuntary risks are found here.

5. Give the reasons for the Three Mile Island disaster?

i. In adequate training to the operators.
ii. Use of B&W reactors.

6. Define "risk".(May/June 2011)(NOV/DEC2014)

A risk is the potential that something unwanted and harmful may occur.Risk = Probability X Consequences.

7. What do you mean by voluntary risk? (May/June 2010, May/June 2010)

- ✓ If a person knowingly takes any risk, then he feels it safe. In contrast, if the same risk is forced to him, then he feels it unsafe.
- ✓ In simple terms the voluntary risks are considered as safe and the involuntary risks are considered as unsafe.

8. What is safe risk and acceptability of risk? (IT Dec 2009,May 2010) Acceptability of risk:

A risk is acceptable when those affected are generally no longer apprehensive about it. Apprehensiveness mainly depends on how the risk is perceived by the people.**Safe Risk:**

If a person knowingly takes any risk then he feels it safe. In the same way voluntary risks are considered as safe risk

9. List the methods that can be applied when testing is inappropriate. (May/june 2009)(NOV/DEC2014)

- ✓ Scenario Analysis
- ✓ Failure modes and effects analysis

- ✓ Fault free analysis
- ✓ Event free analysis

10.What is the use of knowledge of risk acceptance to engineers?

Though past experience and historical data give better information about safety of products designing there are still inadequate .The reasons are

a. The information is not freely shared among industries

b. There also new applications of old technologies that provides available data, which are less useful.

c. So, in order to access the risk of a product, the engineers must share their knowledge and information with others in a free manner.

11. What are the positive uncertainties in determining risks?

a. Purpose of designing

b. Application of the product

c. Materials and the skill used for producing the product

12. What is the Risk Transfer?

It refers to the legal assignment of the cost of certain potential losses from one party to another. The most common way of affecting such transfer is by insurance.

14. State the industrial definition on safety .(MAY/JUNE 2014)

A. A ship in harbor is safe, but that is not what ships are built for‖ – John A. Shedd

B. A thing is safe if its risks are judged to be acceptable„ - William W. Lawrence

C. We buy an ill-designed Iron box in a sale-> Underestimating risk

D. We judge fluoride in water can kill lots of people -> Overestimating risk

E. We hire a taxi, without thinking about its safety -> Not estimating risk

15. What is meant by Disaster? (MAY/JUNE 2014, NOV/DEC 2013))

A DISASTER = A seriously disruptive event + A state of unprepared ness. e.g., Titanic collision with an iceberg, at night: Emergency
Fewer lifeboats, inadequate training and warnings of icebergs unheeded ->Disaster

16. What is informed consent? (MAY/JUNE 2011)(APR/MAY 2015)
Informed consent is the process by which the treating health care provider discloses appropriate information to a competent patient so that the patient may make a voluntary choice to accept or refuse treatment. It originates from the legal and ethical right the patient has to direct what happens to her body and from the ethical duty of the physician to involve the patient in her health care.

17. What is the use of risk analysis? (APR/MAY 2015)
Risk analysis is the process of defining and analyzing the dangers to individuals, businesses and government agencies posed by potential natural and human-caused adverse events.

18. What is collegiality?(May/June 2011, Nov/June 2009, NOV/DEC 2014),(APR/MAY2015) Collegiality is a kind of connectedness grounded in respect for professional expertise and in a
commitment to the goals and values of the profession and collegiality includes a disposition to support and cooperate with one„s colleagues.

19. What are the elements of collegiality? (May/June 2010, NOV/DEC 2014)
1.Respect 2.Commitment, 3.Connectedness 4.Cooperation

20.What do you meant by employee rights and lists its categories? (Nov/Dec 2012)
Employee rights are rights, moral or legal, that involve the status of being an employee. They include some professional rights that apply to the employer-employee relationship.

21. What is the Basic Right of Professional Conscience? (MAY/JUNE 2011)

The right to do what everyone agrees it is obligatory for the professional engineers to do the basic professional right is an entitlement giving one the moral authority to act without interference from others.

22. What is Institutional Recognition of Rights? (NOV/DEC 2011)

One should have moral right, having it respected by others and given

Recognition with in the institution is the other. Koning states in 1975, conference on Engineering Ethics- that one item that should be in the code of ethics is that engineers have the right at all times to exercise the dictates of their own conscience.

23. State the specific right.

Specific rights can be stated as a particular professional obligation to apply Professional rights according to specific circumstances.

24. What are the two basic rights of professional/conscience

First is to proceed piecemeal by reiterating the justification given for the specific professional duties Second, is to justify the right of professional conscience, which involves grounding it more directly in the ethical theories, for organizing moral reflections and approaching practical problem.

25. What is Duty Ethics? (May/June 2011)

Duty ethics rights are not the ultimate moral appeal . Engineers have a right to do something it is only because other have duties or obligations to allow him to do it . No employer has the right to threat engineers with loss of the jobs for refusing to work on project they see as likely to lead to the death or injury of unsuspecting victims.

26. What is Utilitarianism?

Utilitarianism will justify the right of professional conscience by referring to the Basic goal of producing the most good for the greatest number of people the public good is certain to observed by allowing professionals to meet their obligations to the public.

27. What is meant by collective Bargaining?(May/June 2014)

Collective bargaining is a process of negotiations between employers and a group of employees aimed at reaching agreements to regulate working conditions. The interests of the employees are commonly presented by representatives of a to which the employees belong. The collective agreements reached by these negotiations usually set out wage scales, working hours, training, health and safety, overtime, grievance mechanisms, and rights to participate in workplace or company affairs.

28. What is meant by Occupational crime? (May/June 2014)

Occupational Crime

Occupational crimes are illegal acts made possible through one„s lawful employment. It is the secretive violation of laws regulating work activities. When committed by office workers or professionals, occupational crime is called _white collar crime.

29. List the factors that shape the self confidence in a person. (NOV/DEC 2013),(APR/MAY2015)

- ✓ Emphasize Strengths
- ✓ Take Risks.
- ✓ Use Self-Talk.
- ✓ Self-Evaluate.

30. Difference between Bribe and Gift. (NOV/DEC 2014)

Gift: Something of value given without the expectation of return

Bribe: Something of value given with the hope of a future influence or benefit

PART-B

1. Discuss the notion of safe exit using evacuation plans for communities near power plants or Chemical processing plants? **(U) (May/June 2010) (May/June 2014)**

2. What is Risk benefit analysis? Explain the different analytical method used when testing is inappropriate? **(U) (Nov/Dec 2010, May/June2011) (Nov/Dec 2014)**

3. State the necessity of risk benefit analysis **(May/June 2014)**

4. Discuss the Bhopal disaster .Explain the responsibility of engineer in the design stage itself before the event of an accident. **(U) May/June 2014)(Apr/May 2015)**

5. Define the term risk and safety .How will an engineer assess the safety? **(Nov/Dec 2014)**

6. What are the factors that affect risk acceptability? What is the use of knowledge of risk acceptance to engineers?**(Nov/Dec 2013)**

7. a) Describe the concept of (16) **(Apr/May 2015)**

1) Risk benefits analysis.
2) Fault tree analysis.

8. Explain in detail the effect of information on risk assessment with an example **(U) (Nov/Dec 2014)**

9. Discuss the concept of safety exists in the Chernobyl Case Studies? **(Nov/Dec 2014)**

10. Write short notes on

(i) Whistle blowing
(ii) Occupational crime
(iii) Intellectual property rights
(iv) Discrimination
(V) Institution Authority **(April/ May 2013,Nov/Dec 2013)(April/ May 2015)**

11. Name and describe four important responsibilities of engineers as employees.**(Nov/Dec 2011)**

12. Write a detailed note about the employee rights and professional rights that the engineers are entitled. **(April/ May 2010), (Nov/Dec 2013) ,(April/ May 2015)**

13. Discuss about Collegiality and Loyalty? **(May/June 2014) (Nov/Dec 2014)**

14.What are the main element of IPR ?Give example of discrimination? **(May/June 2014)**

15.Discuss human rights,professional rights and employee rights in an engineer field.**(May/June 2014)**

16. Discuss the significance of intellectual property rights. Also explain the legislations covering intellectual property rights in india.**(Nov/Dec 2013) (Nov/Dec 2014)**

17. Discuss the significance of loyalty and collegiality in team work? **(April/ May 2015)**

UNIT V
GLOBAL ISSUES
PART A

1. What is embezzlement? (APRIL/ MAY 2011)

The process of computing computer crimes such as stealing or cheating clients and conspiracy in the fraudulent uses of computer networks is called embezzlement.

2. What the hired guns? (APRIL/ MAY 2011)

Engineers are hired by attorneys to help them to establish the facts in away favorable to their clients. The hired guns violate the standards of honesty and also due care in conducting investigations.

3. What is technology transfer? (APRIL/ MAY 2010)

Technology transfer is a process of changing the technology to a new setting and implementing it. Technology includes hardware such as machines and installations as well as techniques such as technical, organizational and managerial skills and procedures.

4. What does moral leadership mean?(APRIL/MAY2010) (NOV/DEC 2014)

Whenever the goals of a leader become permissible and also morally valuable, it is known as moral leadership. Moral leadership also means that employing morally acceptable ways to motivate the groups to move towards morally desirable ways. The ways are depending on the situations.

5. State the most important ethical mistake made by the multinational corporation which caused Bhopal gas plant disaster. (NOV/DEC 2010)

- The tanks used to store Methyl Iso-cyanate were overloaded to a tune of 75%. The emergency plant was also filled with a large amount of chemicals.

- The entire refrigeration unit had been shut down as a measure to reduce the cost and this led to increase of temperatures to a higher level.
- One of the disappointed workers unscrewed a pressure gauge on a tank and inserted a hosepipe into it, knowing that it would cause damage, but not to this extent.
- Scrubber has also been shut down.
- Flare tower was also not in an operating condition.
- Unfortunately there were no emergency drills or evacuation plants available.

6. Define Conflict resolution. (APRIL/ MAY 2010)

Conflict resolution is the result based on some objective standard and corporate usually uses general standards for evaluating the results.

7. What is contextualize? (APRIL/MAY 2010)

In accordance to Gilligan women try hard to preserve personal relationship will all people. This context-oriented emphasis on maintaining personal relationship is called as ethics of care in contrast with ethics of rules and rights.

8. What are ethical pluralism and ethical relativism? (APRIL/MAY 2010)

Ethical pluralism: According to this view there may be alternative moral perspectives that are reasonable, but no one of which must be accepted completely by all rational and morally concerned persons.

Ethical relativism: Actions are morally right when they are approved by law or custom they are wrong when they violate laws or customers.

9. What should an ethical expert witness, even though hired by a company, expected to do? (APRIL/MAY 2010)

Engineers should not become the hired-guns to their clients, but instead remain as objective as humanly possible in their investigations and the conclusions they reach .they should avoid biases resulting from money ego, and sympathy.

10. What are the international rights listed by Donaldson? (NOV/DEC 2014)

Thomas Donaldson in his book ‗The ethics of International Business„ has listed the following as the International rights:

- ✓ The right to freedom of physical movement
- ✓ The right to ownership of property
- ✓ The right to freedom from torture
- ✓ The right to a fair trial
- ✓ The right to nondiscriminatory treatment
- ✓ The right to physical security
- ✓ The right to freedom of speech and association
- ✓ The right to minimal education
- ✓ The right to political participation
- ✓ The right to subsistence.

11. Define appropriate technology? (IT Nov 2008)

Appropriate technology refers to the identification, transfer and implementation of the most suitable technology for a new set of conditions.

12. List out four examples for Multinational Corporation. (IT Nov 2010)

Large corporations having investment and business in number of countries are known as Multinational or Transnational corporation. Some of them are : Hindustan Lever, Ford, Toyota, Sony, LG, Smith Kline Beecham, ITC, Ponds etc.

13. Define computer ethics?(DEC/NOV2010)

Computers contribute to a variety of moral problems. In order to evaluate andact appropriately with such problems, a new field of applied ethics termed as ‗computer ethics„ has been developed.The study of ethical issues that are associated with computer, its peripheral and accesses series and the computing profession is called as computer ethics.

14. What is meant by globalization?

Our lives are increasingly dependent upon the goods/services produced over the world and are influenced by the business from around all the corners of the world. In general world has become a global village and have a global economy. The increasing international flow of capital, technology, trade, and people have had the effects of changing the nature of local organizations

governments and people of countries and have led to social changes and developments.

15. What are the three senses of relative values? (DEC/ NOV 2012)

- ✓Ethical Relativism
- ✓Descriptive Relativism
- ✓Moral Relativism

16. What are the normal issues arise in Multinational Corporation?(MAY/JUNE 2014)

Ethical dilemmas faced by certain companies may be specific to their industry or company, other types of ethical issues are common to all types of companies. Handling ethical decisions with wisdom is especially important for small businesses, given the potentially devastating effects these companies may face if such issues aren't handled correctly.

17. Differentiate the Eye witness and expert witness in the legal system (MAY/JUNE 2014)

An eyewitness is one who testifies what they perceived through his or her senses (e.g. seeing, hearing, smelling, touching). That perception might be either with the unaided human sense or with the aid of an instrument, e.g., microscope or stethoscope, or by other scientific means, e.g.a chemical reagent which changes color in the presence of a particular substance

An expert witness is one who allegedly has specialized knowledge relevant to the matter of interest, which knowledge purportedly helps to either make sense of other evidence, including other testimony, documentary evidence or physical evidence (e.g., a fingerprint)

18. What is meant by Moral Leadership (NOV/DEC 2013)

Moral Leadership is a very different kind of **leadership**. Rather than aspiring to being followed, **Moral Leaders** aim to serve. Instead of showcasing their own skills, **Moral Leaders** tend to develop the capacities of others.

19. Define the term honesty and moral leadership

Honesty :A facet of moral character that connotes positive and virtuous attributes such as integrity, truthfulness, and straightforwardness, along with the absence of lying, cheating, or theft.

Moral Leadership: A process of social influence in which one person enlists the aid and support of others in accomplishing a common task.

20. What do you understand by business ethics?

Business ethics (also corporate **ethics**) is a form of applied **ethics** or professional **ethics** that examines **ethical** principles and moral or **ethical** problems that arise in a **business** environment. It applies to all aspects of **business** conduct and is relevant to the conduct of individuals and entire organizations.

PART B

1. Explain in detail the issues pertaining to environment issues? (April/ May 2011)
2. Describe the Bhopal Gas Tragedy and its effects?(April/May 11)
3. Is there any relationship among engineering ecology and economics? Discuss? (Nov/Dec 2012)
4. Write briefly on Engineer used as expert witness, Engineers as good managers, Engineers with social responsibilities.(May/June 2013)
5. Discuss the following in detail Business Ethics, Environmental Ethics, Computer Ethics, Weapons Development(Nov/Dec 2013)
6. What is environment ethics? Why it is important to study. Discuss any environment issues in the ethical point of view to engineers. (Nov/Dec 2013),(Apr/May 2015) (Nov/Dec 2014)
7. Discuss the following in detail (May/June 2014)
   Engineers as ManagersEngineers as advisors
   Engineers as consultant
   Moral leadership
8. Discuss the various global issues that have an impact on business.(Apr/May2015)
9. Discuss the ethical issues related to computer ethics and internet(Nov/Dec2014)
10. Explain the use of moral and ethical issues involved in use of Computers**? (April 2017)**
11. Explain the scope and function of Corporate responsibility (Nov 2016)

12. Explain in detail various advantages and disadvantages of MNC's? (Nov 2016)
13. Explain moral obligations of an engineer as per the code of ethics. (April 2014)
14. Describe in detail about the global issues of weapon development.(May 2016)
15. Define computer ethics? Explain the issues related to computer ethics an interest with your personal experience. (Nov 2015)