

**University of Mumbai**  
**Examination May-June 2021 under cluster 9 (FAMT)**

Examinations Commencing from 1<sup>st</sup> June 2021

Program **Mechanical** Engineering

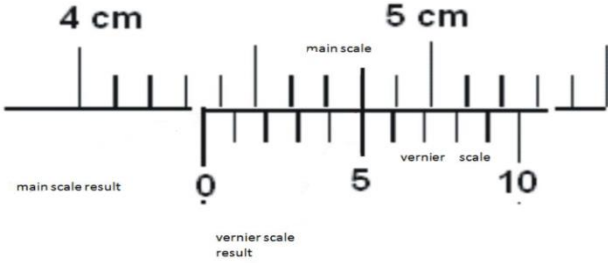
Curriculum Scheme: **Rev2016**

Examination: **TE Semester VI**

Course Code: **MEC601** and Course Name: **Metrology and Quality Engineering**

Time: 2-hour

Max. Marks: 80

Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	Which among the following is not an example of End Standard?
Option A:	Sine bar
Option B:	Vernier Caliper
Option C:	Micrometer
Option D:	Imperial Standard yard
2.	Which of the following components is not a case of Indirect Method of Measurement?
Option A:	Angle measurement by Sine bar
Option B:	Screw pitch diameter by Floating Carriage Micrometer
Option C:	Measuring diameter of shaft using Micrometer
Option D:	Density calculation by measuring mass and dimensions for calculating volume
3.	Use of Nanometrology
Option A:	to make nanomaterials
Option B:	to use nanotechnology
Option C:	to measure dimensions in nano scale
Option D:	to study nano materials
4.	Total Vernier Caliper reading given in Figure is <div style="text-align: center;">  <p>The diagram shows a Vernier Caliper with a main scale and a vernier scale. The main scale has markings from 4 cm to 5 cm. The vernier scale has markings from 0 to 10. The main scale reading is 4.3 cm and the vernier scale reading is 5.</p> </div>
Option A:	4.35 mm
Option B:	4.3 mm
Option C:	4.35 cm
Option D:	4.3 cm
5.	Maximum Hole size is less than Minimum Shaft size it is
Option A:	Transition Fit

Option B:	Interference Fit
Option C:	Clearance Fit
Option D:	Loose fit
6.	While designing the, Go and NO-GO gauge, which allowance is provided only on GO gauge?
Option A:	Positive allowance
Option B:	Wear allowance
Option C:	Negative Allowance
Option D:	Special Allowance
7.	For inspecting the internal diameter of a bush, which type of gauge consume less time
Option A:	Double End Cylindrical Plug Gauge
Option B:	Progressive type Plug Gauge
Option C:	Snap Gauge
Option D:	Ring Gauge
8.	Pneumatic comparator work on a principal of
Option A:	Total Pressure
Option B:	High Pressure
Option C:	Low pressure
Option D:	Back Pressure
9.	Maximum shaft dimension less than Minimum hole dimension
Option A:	Interference Fit
Option B:	Clearance Fit
Option C:	Transition Fit
Option D:	Heavy hammer fit
10.	Arrange the sequence of method providing highest accuracy to low accuracy in measuring pitch diameter a) Best wire size method b)Two wire method c) Three wire method
Option A:	a-b-c
Option B:	c-a-b
Option C:	b-c-a
Option D:	b-a-c
11	The main use of a tool makers' microscope is in measuring
Option A:	Phase shift of monochromatic light
Option B:	Shape, size and angle of small machine component
Option C:	Biological degradation of small machine component
Option D:	Contours of small machine parts

12	Select the odd
Option A:	Bridge type CMM.
Option B:	Column type CMM.
Option C:	Row type CMM.
Option D:	Gantry type CMM
13	The distance between crest and root of the thread measured at right angle to the axis of thread is known as _____ of thread
Option A:	Number of starts
Option B:	form
Option C:	Depth of thread
Option D:	lead
14	In four sigma approach there should be
Option A:	less than 66807 defects per million opportunities
Option B:	less than 233 defects per million opportunities
Option C:	less than 6210 defects per million opportunities
Option D:	less than 3.4 defects per million opportunities...
15	_____ is the set of activities that ensures the quality levels of products and services are properly maintained and that supplier and customer quality issues are properly resolved.
Option A:	Quality Assurance
Option B:	Quality Planning
Option C:	Quality Control
Option D:	Quality Management
16	_____ are the charts that identify potential causes for particular quality problems.
Option A:	Control Chart
Option B:	Flow chart
Option C:	Cause and Effect Diagram
Option D:	Pareto chart
17.	Which of these would decrease the probability of making a Type II error?
Option A:	Increasing the sample size
Option B:	Reducing the fraction defective
Option C:	Increasing the AQL
Option D:	Reducing the LTPD
18.	Which of the following is used to represent the probability of accepting lots with various fractions defective?
Option A:	Sampling plan.
Option B:	OC curve.
Option C:	power test.
Option D:	indifference analysis.
19.	Which NDT test does not require skilled labour
Option A:	Dye penetrant testing
Option B:	Radiographic inspection

Option C:	Ultrasonic testing
Option D:	Magnetic particle test
20.	Which among the following is the last step in magnetic particle test method?
Option A:	Demagnetization
Option B:	Observation and inspection
Option C:	Magnetization
Option D:	Circular magnetization

<b>Q2.</b>	<b>Solve any Two Questions out of Three</b>	<b>10 marks each</b>																																
A	Explain types of fits with neat sketches and suitable examples.																																	
B	Illustrate working principle of optical profile projector with its neat sketch and advantages																																	
C	In a manufacturing process the number of defectives found in the inspection of 15 lots of 400 items each are given below,																																	
	<table border="1"> <tr> <td>Lot No.</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td> </tr> <tr> <td>No. of defectives</td> <td>02</td><td>05</td><td>03</td><td>04</td><td>00</td><td>06</td><td>08</td><td>07</td><td>04</td><td>03</td><td>05</td><td>10</td><td>12</td><td>07</td><td>09</td> </tr> </table>		Lot No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	No. of defectives	02	05	03	04	00	06	08	07	04	03	05	10	12	07	09
	Lot No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																		
No. of defectives	02	05	03	04	00	06	08	07	04	03	05	10	12	07	09																			
Determine, i. The trial control limits for 'np chart' and state whether the process is in control. ii. New value of mean fraction defective, if points outside control limits are eliminated. what will be the corresponding upper and lower control limit and examine whether the process is still in control or not.																																		

<b>Q3.</b>	
<b>A</b>	<b>Solve any Two</b>
i.	Explain the significance of Nanometrology
ii.	Distinguish between Single sampling and Double Sampling plans
iii.	Explain with neat labelled diagram Dye Penetrant testing and its applications
<b>B</b>	<b>Solve any One</b>
i.	Explain the construction and working of Johansson Mikrokator
ii	Illustrate working principle of any two types of CMM with its advantages

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**Examinations Commencing from 1<sup>st</sup> June**

Program: Mechanical Engineering

Curriculum Scheme: Rev2016

Examination: TE Semester VI

Course Code MEC602 and Course Name: Machine Design-I

Time: 2 hour

Max. Marks: 80

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Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	The ratio of the ultimate stress to the design stress is known as
Option A:	elastic limit
Option B:	strain
Option C:	factor of safety
Option D:	bulk modulus
2.	In cyclic loading, stress concentration is more serious in
Option A:	brittle materials
Option B:	ductile materials
Option C:	brittle as well as ductile materials
Option D:	elastic materials
3.	In a thick cylindrical shell, the maximum radial stress at the outer surfaces of the shell is
Option A:	zero
Option B:	$p$
Option C:	$-p$
Option D:	$2p$
4.	Which of the following statement is incorrect in case of factors to be considered while designing machine parts to avoid Fatigue Failure?
Option A:	The variation in the size of the component should be as gradual as possible.
Option B:	The holes, notches and other stress raisers should be avoided.
Option C:	A smooth finish of outer surface of the component increases the fatigue life.
Option D:	The material with high fatigue strength should be avoided.
5.	Which of the following is a permanent fastening
Option A:	Bolts
Option B:	Rivets
Option C:	Keys
Option D:	Cotter
6.	Failure of a material is called fatigue when it fails
Option A:	at the elastic limit
Option B:	below the elastic limit
Option C:	at the yield point
Option D:	below the yield point

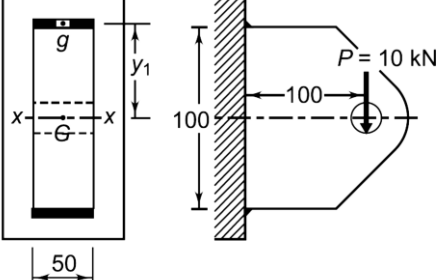
7.	The maximum bending stress, in a curved beam having symmetrical section, always occur, at the
Option A:	centroidal axis
Option B:	neutral axis
Option C:	outside fibre
Option D:	inside fibre
8.	Select an appropriate option for a diagram
Option A:	Completely reversed stress
Option B:	Repeated Stress
Option C:	Fluctuating Stress
Option D:	Non Repeated stress
9.	Which of the following type is not a type of End Connections for Compression Helical Springs?
Option A:	Plain ends
Option B:	Ground ends
Option C:	Squared ends
Option D:	Triangular ends
10.	The castings produced by forcing molten metal under pressure into a permanent metal mould is known as
Option A:	permanent mould casting
Option B:	slush casting
Option C:	die casting
Option D:	centrifugal casting
11.	According to IS : 1076 (Part I)–1985 (Reaffirmed 1990), which is not a preferred number of the basic series of R5
Option A:	1.50
Option B:	1.60
Option C:	2.50
Option D:	4.00
12.	Hooke's law holds good upto
Option A:	yield point
Option B:	elastic limit
Option C:	plastic limit
Option D:	breaking point



	are the mean coil diameter and wire diameter respectively. For considering the effect of curvature, the Wahl's stress factor $K$ is given by
	$(a) \frac{4C-1}{4C+4} + \frac{0.615}{C}$ $(b) \frac{4C-1}{4C-4} + \frac{0.615}{C}$ $(c) \frac{4C+1}{4C-4} - \frac{0.615}{C}$ $(d) \frac{4C+1}{4C+4} - \frac{0.615}{C}$
Option A:	(c)
Option B:	(d)
Option C:	(a)
Option D:	(b)
20.	Torsional strength of shaft is written as
	$(a) \frac{\pi}{32} d^4 \tau$ $(b) d \log_e \tau$ $(c) \frac{\pi}{16} d^3 \tau$ $(d) \frac{\pi}{32} d^3 \tau$
Option A:	(c)
Option B:	(d)
Option C:	(a)
Option D:	(b)

<b>Q2.</b>	<b>Solve any Two Questions out of Three (10 marks each)</b>
A	Design a Knuckle joint subjected to an axial pull of 10kN. Selecting suitable material for all the parts decide the allowable stresses. Design should include figures for the Joint and failure areas?
B	A shaft is supported by two bearings placed 1 m apart. A 550 mm diameter pulley is mounted at a distance of 350 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 350 mm diameter is placed 210 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is $180^\circ$ and $\mu = 0.24$ . Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.
C	Draw a crane hook and check for critical sections for a load of 12 tonnes.



Q3.	Solve any Two Questions out of Three <span style="float: right;">10 marks each</span>	
A	<p>A bracket is welded to the vertical column by means of two fillet welds as shown in the figure. Determine the size of the welds, if the permissible shear stress in the weld is limited to <math>70 \text{ N/mm}^2</math>.</p>	
B	<p>Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 22 kW at 960 r.p.m. The overall torque is 10 percent more than mean torque.</p> <p>The material properties are as follows :</p> <p>(a) The allowable shear and crushing stress for shaft and key material is 40 MPa and 80 MPa respectively.</p> <p>(b) The allowable shear stress for cast iron is 15 MPa.</p> <p>(c) The allowable bearing pressure for rubber bush is <math>0.8 \text{ N/mm}^2</math>.</p> <p>(d) The material of the pin is same as that of shaft and key.</p> <p>Draw neat sketch of the coupling.</p>	
C	<p>Design and draw a valve spring of a petrol engine for the following operating conditions : Spring load when the valve is open = 400 N, Spring load when the valve is closed = 250 N Maximum inside diameter of spring = 25 mm, Length of the spring when the valve is open= 40 mm, Length of the spring when the valve is closed= 50 mm, Maximum permissible shear stress = 400 MPa</p>	

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**University of Mumbai**  
**Examination 2021 under cluster 9 (FAMT)**

**Examinations Commencing from 1<sup>st</sup> June 2021**

Program: Mechanical Engineering

Curriculum Scheme: 2016

Examination: TE Semester VI

Course Code: MEC603 and Course Name: Finite Element Analysis

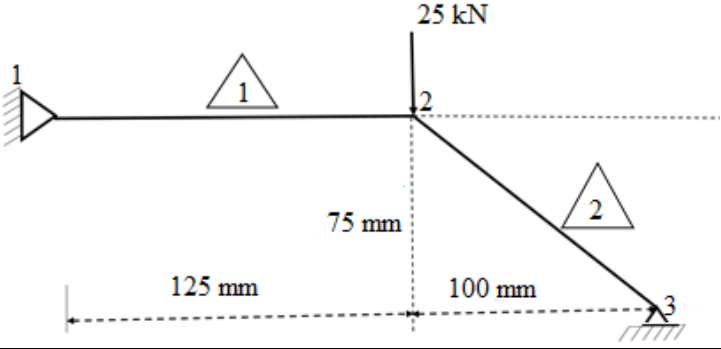
Time: 2 hour

Max. Marks: 80

Q1.	<b>Choose the correct option for following questions. All the Questions are compulsory and carry equal marks</b>
1.	Which of the following is the advantage of FEM?
Option A:	FEM is an approximation and results are not correct
Option B:	Results depend on the experience and judgment of the designer
Option C:	Solve and analyze the complex geometry problems
Option D:	High end hardware is needed
2.	The process of stitching of all elements together is called as
Option A:	Assemblage
Option B:	Discretization
Option C:	Continuum
Option D:	Traction
3.	How Rayleigh-Ritz method can be differentiated from other numerical methods?
Option A:	Weighted residue
Option B:	Weak form type
Option C:	Non-weak form type
Option D:	Variational
4.	What is the axial rigidity of an axial bar of length 'L' with a uniform cross sectional Area 'A' and Modulus of Elasticity 'E'?
Option A:	EA
Option B:	E/A
Option C:	EA/L
Option D:	A/E
5.	What is number of internal nodes of a linear element?
Option A:	0
Option B:	2
Option C:	1
Option D:	3
6.	What is the order of a 1D quadratic element?
Option A:	1
Option B:	2
Option C:	3
Option D:	4

7.	What is the balance of secondary variables at a given node in the absence of external secondary variable?
Option A:	One
Option B:	Zero
Option C:	Not equal to zero
Option D:	Exactly two
8.	What is the exact solution for ODE $3y''-y' = 0$ ; $0 \leq x \leq 1$ ? Boundary Conditions: $y(0) = 0$ , $y(3) = 1$
Option A:	$-0.6814 + 0.6814e^x$
Option B:	$-0.5814 + 0.5814e^{x/3}$
Option C:	$-0.5814 + 0.5814e^x$
Option D:	$-0.6814e^{x/3} + 0.6814e^{x/3}$
9.	According to Lagrange polynomial the shape function at node one of a five noded element is given by .....
Option A:	$\Phi_1 = \frac{(x-x_2)(x-x_3)(x-x_4)(x-x_5)}{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}$
Option B:	$\Phi_1 = \frac{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}$
Option C:	$\Phi_1 = \frac{(x-x_2)(x-x_3)(x-x_4)(x-x_5)}{(x_2-x_1)(x_3-x_1)(x_4-x_1)(x_5-x_1)}$
Option D:	$\Phi_1 = \frac{(x-x_2)(x-x_3)(x-x_4)(x-x_5)}{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}$
10.	In the .....element, the load is assumed to act uniformly over the entire cross-section.
Option A:	Truss
Option B:	Plane strain
Option C:	Thin shell
Option D:	Thick shell
11.	The global stiffness matrix is always .....
Option A:	Square, un-symmetric, non-singular and positive definite.
Option B:	Square, symmetric, non-singular and negative definite.
Option C:	Non-square, non-symmetric, non-singular and positive definite.
Option D:	Square, symmetric, singular and positive definite.
12.	In a structure, if there are 2 fixed dof and the size of global stiffness matrix is 6 x 6, then as per elimination approach the storing stiffness matrix has the order of .....
Option A:	2 x 2
Option B:	3 x 3
Option C:	4 x 4
Option D:	6 x 6
13.	Serendipity elements are element with
Option A:	Only internal node
Option B:	Only external nodes
Option C:	Both internal and external nodes
Option D:	Only nodes at boundary

14.	Patch test is performed to ensure
Option A:	Formulation Criteria
Option B:	Discretization criteria
Option C:	Convergence criteria
Option D:	Divergence Criteria
15.	Which error is caused due to truncation
Option A:	Discretization error
Option B:	Formulation error
Option C:	Numerical error
Option D:	Convergence error
16.	In a CST element
Option A:	Displacement is constant
Option B:	Displacement is linear
Option C:	Displacement is quadratic
Option D:	Displacement is cubic
17.	The dimension of the Stress-Strain Relation (D) matrix for 2D analysis is
Option A:	2x2
Option B:	3x3
Option C:	4x4
Option D:	6x6
18.	The total DOF of a CST element is
Option A:	3
Option B:	4
Option C:	6
Option D:	8
19.	The size of the element mass matrix of a CST element for the plane stress condition is .....
Option A:	2 x 2
Option B:	4 x 4
Option C:	6 x 6
Option D:	8 x 8
20.	..... represents a set of relative displacements in various degrees of freedom.
Option A:	Mode shape
Option B:	Eigenvalues
Option C:	Eigenvectors
Option D:	Characteristic equation

<b>Q2</b> <b>(20 Marks)</b>	<b>Solve any Two Questions out of Three (10 marks each)</b>
A	Solve the following differential equation and determine y at x=0.5 using Galerkin Method. $\frac{d^2y}{dx^2} - 10x^2 - 5 = 0$ in the domain $0 \leq x \leq 1$ Boundary conditions are: $y(0) = 0$ and $y(1) = 0$
B	Determine the nodal displacement and stresses in each element. Consider the cross-sectional area of each member of truss as $100 \text{ mm}^2$ and modulus of elasticity as $100 \text{ GPa}$ . 
C	The nodal coordinates of a three node triangular element are (4, 6), (13, 8) and (10, 12). Determine the shape functions at a point P (9, 8).


<b>Q3</b> <b>(20 Marks)</b>	<b>Solve any Four out of Six (5 marks each)</b>
A	Solve the following governing differential equation using least square method. $3 \frac{dy}{dx} - x = 0$ in the domain $0 \leq x \leq 1$ Boundary condition is: $y(0) = 1$
B	Solve the following Governing Differential Equation considering the two linear elements by directly using Element Matrix Equation (Avoid its development) for displacements and forces at nodes. Take $A = 0.1 \text{ m}^2$ , $E = 100 \text{ GPa}$ . External force, $P = 10 \text{ kN}$ as shown in figure 1. $\frac{d}{dx} \left[ AE \frac{du}{dx} \right] = 0 \quad 0 \leq x \leq 12 \text{ cms}$ 
C	Determine the nodal displacement for the step bar shown in figure. Consider, $L_1 = L_2 = 100 \text{ mm}$ , $A_1 = 100 \text{ mm}^2$ , $A_2 = 50 \text{ mm}^2$ , $E_1 = E_2 = 100 \text{ GPa}$ , and $P = 5,000 \text{ N}$ .

Fig 1. Horizontal Bar subjected to axial load

D	Explain Jacobian Matrix
E	A iso parametric four node quadrilateral element ABCD has coordinates A(10,5), B(12,6) , C(15,8) and D(8,4). Determine the Cartesian coordinate of a point P which has local coordinate $\xi= 0.8$ and $\eta= 0.2$
F	<p>Determine the natural frequency of vibration using consistent mass matrix with one bar element. An aluminum bar has a uniform cross-section, length 1 m and made up of a material having <math>E = 70 \times 10^9 \text{ N/m}^2</math> and <math>\rho = 2700 \text{ kg/m}^3</math>.</p>

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**Examinations Commencing from 1<sup>st</sup> June 2021**

Program: Mechanical Engineering

Curriculum Scheme: Rev2016

Examination: TE Semester VI

Course Code: MEC604 and Course Name: Refrigeration and Air Conditioning

Time: 2 hour Max. Marks: 80

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<b>Q1.</b>	<b>Choose the correct option for following questions. All the Questions are compulsory and carry equal marks</b>
1.	For a space to be air conditioned, Room Sensible heat is 400 kW and Room Latent heat is 200 kW. The room sensible heat factor will be _____.
Option A:	2
Option B:	4/7
Option C:	2/3
Option D:	3/5
2.	One Ton of refrigeration is equal to _____
Option A:	1 kW
Option B:	10000 kW
Option C:	3.52 kW.
Option D:	7.2 kW
3.	If a Refrigerator and heat pump are operating between two temperature limits of 300K and 600K. COP of Heat Pump and Refrigerator will be _____ respectively.
Option A:	3 and 4
Option B:	2.24 and 3.24
Option C:	3.24 and 2.24
Option D:	2 and 1
4.	In steam jet refrigeration system, the refrigerant used is _____
Option A:	R 718
Option B:	R 12
Option C:	R 717
Option D:	R 134a
5.	Nozzle Diffuser section is used in _____
Option A:	Heat exchanger
Option B:	Ram compression
Option C:	Jet Compression
Option D:	Reciprocating compressor
6.	In which of the following refrigeration methods there is no phase change of the refrigerant?
Option A:	Steam Jet Refrigeration
Option B:	Vapour Compression Refrigeration
Option C:	Vapour Absorption Refrigeration

Option D:	Air Refrigeration
7.	Star ratings for electricity consumption of equipment are assigned by_____.
Option A:	Bureau of Energy Efficiency
Option B:	Best Efficiency of Engine
Option C:	Bureau of Electrical Engineering
Option D:	Best Effectiveness of Energy
8.	In a VCR, which one of the following process is assumed to be constant enthalpy process?
Option A:	Evaporation
Option B:	Compression
Option C:	Throttling
Option D:	Condensation
9.	Intercooling is done to achieve_____.
Option A:	More refrigeration effect.
Option B:	Less work input
Option C:	Lower evaporator temperature
Option D:	Higher condenser temperature
10.	R717 is the designation of _____.
Option A:	Ammonia
Option B:	Air
Option C:	CO <sub>2</sub>
Option D:	Water
11.	Air washer is used to cool_____.
Option A:	Refrigerant
Option B:	Air
Option C:	Water
Option D:	Oil
12.	Which one of the following is a primary refrigerant?
Option A:	R12
Option B:	R717+Water
Option C:	NaCl+Water
Option D:	LiBr + Water
13.	Which type of compressor is used in a domestic refrigerator?
Option A:	Hermetically sealed compressor
Option B:	Centrifugal compressor
Option C:	Screw compressor
Option D:	Axial compressor
14.	Receiver is used to _____.
Option A:	Allow entry of liquid refrigerant in throttle valve
Option B:	Store the liquid refrigerant
Option C:	Avoid entry of liquid refrigerant in evaporator
Option D:	Allow entry of liquid refrigerant in condenser



15.	As compared to VCR, in a VAR system which one of the following components is absent?
Option A:	Pump
Option B:	Evaporator
Option C:	Condenser
Option D:	Compressor
16.	Electrolux cycle is called as ____ fluid system.
Option A:	2
Option B:	3
Option C:	4
Option D:	1
17.	_____ refrigeration uses sound waves.
Option A:	Thermoelectric
Option B:	Thermoacoustic
Option C:	Vortex tube
Option D:	Vapour absorption
18.	Which one of the following psychrometric process is not achieved in an air washer?
Option A:	Cooling and Dehumidification
Option B:	Heating and Dehumidification
Option C:	Heating and Humidification
Option D:	Cooling and Humidification
19.	In adiabatic humidification, _____ remains constant.
Option A:	Enthalpy
Option B:	Relative Humidity
Option C:	Dry Bulb Temperature
Option D:	Dew Point Temperature
20.	Infiltration load occurs due to _____.
Option A:	Electronic equipment
Option B:	Sun
Option C:	Human
Option D:	Leakage

<b>Q2</b> <b>(20 Marks Each)</b>	
<b>A</b>	<b>Solve any Two . (5 marks each)</b>
i.	Define a) Coolingtower range b) Cooling tower approach c) Cooling tower efficiency
ii.	Explain the effect of condenser pressure on COP of VCRS with P-h plot.
iii.	Explain bootstrapair refrigeration systems with neat sketch.
<b>B</b>	<b>Solve any One 10marks each</b>
i.	An aircraft refrigeration plant has to handle a cabin load of 25 TR. The atmospheric temperature is 16°C. The atmospheric air is compressed to a pressure of 0.96 bar and temperature of 29°C due to ram action. This air is then further compressed in a compressor to 4.8 bar, cooled in a heat

	exchanger to 66°C, expanded in a turbine to 1 bar pressure and supplied to the cabin. The air leaves the cabin at a temperature of 26°C. The isentropic efficiencies of both compressor and turbine are 0.85 Calculate: (i) The Mass of air circulated per minute (ii) COP.
ii.	A vapour compression system using R12 is works between -15 °C and 35°C as evaporator and condenser temperature respectively. Use p-h chart determine: 1) COP 2) mass flow of refrigerant per TR 3) Piston displacement per TR using volumetric efficiency=85% iv) Heat rejected in the condenser per TR and v) Ideal COP.

<b>Q3.</b> <b>(20 Marks Each)</b>	
<b>A</b>	<b>Solve any Two. (5 marks each)</b>
i.	Define 1) Bypass factor 2) Room Sensible Heat Factor
ii.	Represent the psychrometric process: a) Cooling with dehumidification b) Heating with dehumidification.
iii.	Explain with neat sketch deep sea water air-conditioning?
<b>B</b>	<b>Solve any One 10marks each</b>
i.	A duct of rectangular cross section 600 mm × 400mm, 100m length carries 90 m <sup>3</sup> /min of air having density 1.2 kg/m <sup>3</sup> . Determine equivalent diameter of a circular duct if 1) The quantity of air passing through both the ducts is same 2) The Velocity of air passing through both the ducts is same. (Take f = 0.011)
ii.	The humidity ratio of atmospheric air at 1.013 bar and 25°C dry bulb temperature and specific humidity is 0.011 Kg/Kg of dry air. Find using psychrometry chart: 1) Partial Pressure of Water Vapor, 2) Relative Humidity, 3) Dew Point Temperature, 4) Specific Enthalpy, & 5) Vapor Density.

**University of Mumbai**  
**Examination May-June 2021 under cluster 9(FAMT)**

**Examinations Commencing from 1<sup>st</sup> June 2021**

Program: BE Mechanical Engineering

Curriculum Scheme: Rev2016

Examination: Third Year Semester VI

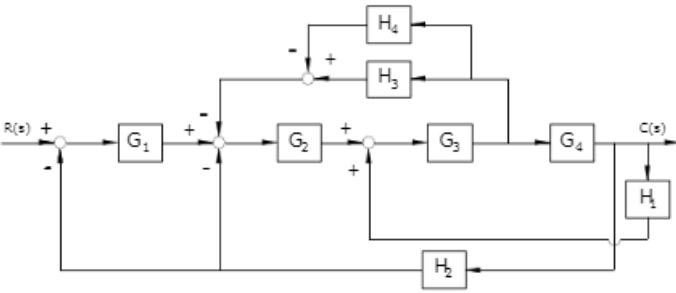
Course Code: MEDLO6021 and Course Name: Mechatronics

Time: 2hour Max. Marks: 80

<b>Q1.</b>	<b>Choose the correct option for following questions. All the Questions are compulsory and carry equal marks</b>
1.	A one-way valve that lets air into the reservoir of a compressor, but doesn't let it out, is a
Option A:	Check valve
Option B:	Control valve
Option C:	Receiver valve
Option D:	Three way valve
2.	Which of the following logic valve is known as shuttle valve?
Option A:	OR gate
Option B:	AND gate
Option C:	NOR gate
Option D:	NAND
3.	What is the notation used for the sequence of operations mentioned below? 1. Cylinder B undergoes forward stroke 2. Cylinder A undergoes forward stroke 3. Cylinder A undergoes backward stroke 4. Cylinder B undergoes backward stroke
Option A:	B- A- A+ B+
Option B:	(BA)- (A B)+
Option C:	B+ A+ A- B-
Option D:	(BA)+ (A B)-
4.	Consider the open loop transfer function $(K(s+5)) / ((s+2)(s+6))$ . In the root locus diagram the centroid will be located at:
Option A:	-1
Option B:	-2
Option C:	-3
Option D:	-4
5.	PID controller stands for
Option A:	Proportional-Internal-Divider Controller
Option B:	Proportional-Integral-Derivative Controller
Option C:	Practical-Internal-Differential Controller
Option D:	Practical-Integral-Derivative Controller
6.	Which of the following cannot be an input that is given to the PLC?
Option A:	Manual switch

Option B:	Relay
Option C:	Sensor
Option D:	LED Bulb
7.	For the programing of Programming Logic Controller (PLC) we use
Option A:	C-Programming
Option B:	Python Programming
Option C:	Ladder logic programming
Option D:	CNC Programming
8.	An example of discrete (digital) control is
Option A:	Varying the volume of a music system
Option B:	Turning a lamp ON or OFF
Option C:	Varying the brightness of a lamp
Option D:	Controlling the speed of a fan
9.	According to Hurwitz criterion the characteristic equation $S^3 + s^2 + 2s + 24 = 0$ is
Option A:	Stable
Option B:	Marginally stable
Option C:	Conditionally stable
Option D:	Unstable
10.	In Nyquist criterion roots of the characteristic equation are given by
Option A:	Zeros of open loop transfer function
Option B:	Zeros of closed loop transfer function
Option C:	Poles of closed loop transfer function
Option D:	Poles of open loop transfer function
11.	_____ is the time required for the response to reach 50% of the final value in the first attempt.
Option A:	Rise time
Option B:	Peak time
Option C:	Settling time
Option D:	Delay time
12.	With a stator having 8 teeth and a rotor having 6 teeth in a stepper motor, step angle will be
Option A:	7.5°.
Option B:	15°.
Option C:	30°.
Option D:	45°.
13.	Transducer is used to convert a _____
Option A:	physical quantity into an electrical signal
Option B:	electrical signal into a physical quantity
Option C:	physical quantity into a mechanical quantity
Option D:	physical quantity into a chemical quantity
14.	A low-pass filter has a cutoff frequency of 1.5 kHz. Determine the bandwidth of the filter.

Option A:	0.75 kHz.
Option B:	1.50 kHz.
Option C:	2.25 kHz
Option D:	3.00 kHz
15.	the output impedance of the R-2R resistor network is always equal to _____, regardless of the size (number of bits) of the network.
Option A:	0.5R
Option B:	R
Option C:	2R
Option D:	3R
16.	What is the input of the data acquisition system (DAQ) to which a transducer is connected called?
Option A:	control element
Option B:	interface
Option C:	channel
Option D:	function
17.	If blocks are in parallel, and the gain is G1 and G2. What will be the gain of resultant block
Option A:	$G1+G2$
Option B:	$G1/G2$
Option C:	$G1*G2$
Option D:	$1+G1G2$
18.	Match the following notations with their meanings: A. G(s) ----- 1) Laplace of error signal B. H(s) ----- 2) Laplace of output signal C. C(s) ----- 3) Forward transfer function D. E(s) ----- 4) Feedback transfer function
Option A:	A- 2, B- 3, C- 1, D- 4
Option B:	A- 3, B- 4, C- 2, D- 1
Option C:	A- 2, B- 3, C- 4, D- 1
Option D:	A- 1, B- 2, C- 3, D- 4
19.	While shifting a take-off point after the summing point, which among the following should be added?
Option A:	Summing point in series with take-off point
Option B:	Summing point in parallel with take-off point
Option C:	Block of reciprocal transfer function
Option D:	Block of inverse transfer function
20.	What does the numbers in 3/2 valve mean?
Option A:	3 positions and 2 ports
Option B:	2 positions and 2 ports
Option C:	2 positions and 3 ports
Option D:	3 positions and 3 ports

<b>Q2</b>	<b>Solve any Two Questions out of Three</b>	<b>10 marks each</b>
A	Determine the transfer function of the mechatronic system shown in figure. 	
B	Illustrate working of i) Tactile sensor ii) Thermocouple. Enlist four applications for each of this sensor.	
C	Illustrate with a circuit diagram the working of i) R-2R circuit ii) ADC Successive Approximation .	

<b>Q3</b>	<b>Solve any Two Questions out of Three</b>	<b>10 marks each</b>
A	Two double acting pneumatic cylinders A and B are selected for an industrial application. The sequence of movement for piston of the cylinder is proposed as below. A+ B+ DelayA- B- Develop an electro-pneumatic circuit using 5/2 double solenoid as final directional control valves.	
B	Sketch the Bode plots for the following transfer function. Determine phase margin, gain margin, phase crossover frequency, gain crossover frequency. Comment on the stability of the system. $G(s) = \frac{80}{s(s+2)(s+10)}$	
C	Develop a ladder logic diagram to implement the process illustrated in Figure. An up-counter must be programmed as part of a batch-counting operation to sort parts automatically for quality control. The counter is installed to divert 1 part out of every 1000 for quality control or inspection purposes. The circuit operates as follows: <ul style="list-style-type: none"> <li>• A star/stop pushbutton station is used to turn the conveyor motor on and off.</li> <li>• A proximity sensor counts the parts as they pass by on the conveyor.</li> <li>• When a count of 1000 is reached, the counter's output activates the gate solenoid, diverting the part to the inspection line.</li> <li>• The gate solenoid is energized for 2 s, which allows enough time for the part to continue to the quality control line.</li> <li>• The gate returns to its normal position when the 2 s time period ends.</li> <li>• The counter resets to 0 and continues to accumulate counts.</li> <li>• A reset pushbutton is provided to reset the counter manually.</li> </ul> 