MOOC QP Set 1

Principles of Vibration Control

(TOTAL = 100 marks)

Section I : 20 questions x 1 mark/question = 20 marks

Section II : 20 questions x 2 marks/question = 40 marks

Section III : 8 questions x 5 marks/question = 40 marks

Section I [20 Questions] - 1 marks/question

1. A Single degree of freedom system having stiffness 10 N/m and mass 2 kg is subjected to an excitation of 100 Hz, which parameter will be important for vibration control?
   - Change Elastic modulus of the material
   - Change stiffness of the material
   - Mass of the material
   - Damping of the material
   - Friction of the system

2. A tuned mass damper is to be designed for a primary system with stiffness 50 N/m and mass 10 kg, the spring attached with the tuned mass has stiffness 1000 N/m and the harmonic excitation force amplitude is 100 N, at perfectly tuned condition, the secondary mass displacement will be?
   - 0.02m
   - 2m
   - 0
   - 0.1m
   - 1m

3. Damping is important for the following application
   - High Strength of Beams and Plates
   - Vibration Control of muffler
   - Fracture toughness of Aircraft Wing
   - Deflection control of Columns
   - Reaction Control of Piston Cylinders

4. A vibrating system is dissipating energy at the rate of 0.01 J per ten cycle. Maximum potential energy of the system is 10 J. The loss factor for the system is
   - 0.001
   - 0.1
   - 1.01
   - 0.011
   - 0.0001

5. In a hysteretic damping system, the α is 3.14 x 10^{-2}, the excitation frequency is 10 rad/sec the equivalent damping constant will be?
   - 10^{-3}
   - 0.01
   - 3.14
   - 31.4
   - None of these

6. What are the appropriate parameters for the Maxwell model in terms of Generalized Hooke's law?
   - [a_0 =1, a_1 = 1, b_0 =E, b_1 =0]
   - [a_0 =1/η, a_1 = 1/E, b_0 =0, b_1 =1]
   - [a_0 =1/η, a_1 = 0, b_0 =E, b_1 =η]
   - [a_0 =1, a_1 = 0, b_0 =0, b_1 =1]
   - None of these

7. The loss factor for a material whose loss modulus and storage modulus is same will be
   - In the range of 0.1 to 5 GPa
   - 1
   - 200 to 500 GPa
   - 45
   - None of these

8. Consider a four cylinder two stroke engine auto-tuned by a Tuned Mass Damper. What will be the length of the pendulum if the shaft radius is 16 cm?
   - 0.25 cm
   - 1.0 cm
   - 2.5 cm
   - 1.6 m
   - None of these

9. A Hand-held hair cutter has 60Hz power supply. What should be done to the hair-cutter to reduce uncomfortable vibration?
   - Add an AMD with 6Hz natural frequency
   - Add a TMD with 10 Hz natural frequency
   - Add a DVA with 30 Hz natural frequency
   - Add an AMD with 60 Hz natural frequency
   - Add a TMD with 60 Hz natural frequency

10. Houdaille Damper is basically

- A TMD
- A Stockbridge Damper
- An AMD
- Both a Stockbridge damper and an AMD
- None of these

11. Active vibration control does not require

- Sensor
- Actuator
- Viscoelastic medium
- Power Amplifier
- Microprocessor

12. Find the incorrect statement?

- Spillover is bad for Active vibration control
- Distributed Control may avoid spill-over
- The chance of spill-over is high in continuous system
- SISO controller is designed for resisting spill-over
- Detuning is not a type of spill-over controller

13. Find the correct flow in Closed loop active vibration control?

- Reference, Comparison with sensing, Controller, Actuator, Vibrating body, Sensor, Comparator
- Reference, Comparison with sensing, Sensor, Actuator, Vibrating body, Comparator, Controller
- Reference, Comparison with sensing, Controller, Sensor, Actuator, Comparator, Vibrating body
- Reference, Comparison with sensing, Controller, Actuator, Sensor, Vibrating body, Comparator
- None

14. The following factor will control the choice of Active vibration control

- Cost
- Availability of sensor
- Nature of structure
- Type of application
- All are correct

15. What is not true about Vortex Induced Vibration?

- It depends on the nature of flow
- It depends on the shape of the bluff-body
- It generally forms a vortex street in the downstream
- It is bad for energy harvesting
- It can have catastrophic consequence

16. Hysteretic Damping Coefficient is used for

- Measuring vortex induced vibration
- Active vibration control
- Vibration isolator
- Structural damping
- All are correct

17. Damping Ratio can be measured by the following technique:

- From the logarithmic decrement of response with respect to time
- From the half-power points of the frequency response function
- By measuring the overshoot from unit step response
- By measuring the Q-factor
- All are correct

18. Which one is not related to Suite?

- Vibration Isolation
- Stewart Platform
- Satellite Deployment
- Vibration Coat
- All are correct

19. Find the odd one?

- Inertia – Kinetic Energy
- Torsional Spring – Potential Energy
- Coulomb Friction - Damping
- Nitrile Rubber – Energy Dissipation
- Holes in Structure – Potential Energy

20. Serrated Jet Exit is an example of

- Vibration reduction at source
- Dynamic Vibration Absorber
- Active Control
- Vortex Induced Vibration
- Constrained Layer Damping

Section II [20 Questions] - 2 marks/question

21. What is possibly not an adverse effect of vibration?

- Fatigue failure in diesel engine
- Chattering of machine tool
- Musical string resonance
- Transmission power line vibration
- Malfunctioning of satellite during rocket launching

22. Self-excited chatter is

- Originated from fluid-structure interaction
- Good for machining process
- An outcome of brain-machine interaction
- A case of active vibration control
- Caused due to uneven surface of the work piece

23. A Camshaft assembly of a diesel engine is most likely to fail due to

- Periodic variation in vehicle speed
- Periodic variation of gas pressure
- High temperature and corrosion
- Secondary Creep
- Combustion corrosion

24. Find the incorrect statement?

- Anti-vibration mount is used for vibration isolation
- Effective parameters for vibration isolation depend on the excitation ratio
- Modulus of elasticity of viscoelastic material varies with both frequency and temperature
- Cast Iron has higher damping than steel
- Stiffness of a structural element varies only with the elastic moduli

25. Correct Order of Damping (high to low) of engineering material elements

- Concrete, Cast Iron, Steel, Brass, Aluminium
- Concrete, Aluminium, Cast Iron, Steel, Brass
- Brass, Steel, Aluminium, Cast Iron, Concrete
- Aluminium, Cast Iron, Concrete, Steel, Brass
- None of these

26. The following is false for decoupling in vibration control

- It is applicable for structures with periodic support
- It may need separation of frequency bands
- Low torsional stiffness and high bending stiffness could be used as a strategy
- Z section is superior to Box section in decoupling
- Box section is superior to Z section in decoupling

27. Damping Capacity of the structural materials will not depend on the following factor

- Dislocation mechanism
- Magneto-elastic coupling
- Grain Boundary slip
- Substitution reaction
- Localized plastic strain

28. Which is true in the case of structural hysteresis at a very low stress level?

- At low stress level the damping index, n = 2
- Hysteresis Curve gets pointed tip
- Hysteresis Curve becomes elliptic
- At low stress level the damping index, n = 2 and hysteresis curve gets pointed tip
- At low stress level the damping index, n = 2 and hysteresis curve becomes elliptic

29. Find out the odd couple?

- Vibration reduction at source – Spiral chimney stairs
- System modification – Constrained layer damping
- Vibration isolation – Anti-vibration mount
- Overhead water tank in a tall structure – Decoupling
- Tuned mass damper – Stock Bridge damper

30. Energy Dissipation in Viscous Damping

- Varies directly with square of amplitude
- Varies inversely with the frequency
- Varies inversely with damping
- Varies directly with amplitude
- None of these

31. What is the correct expression of Material Loss Factor?

- $D_m/(2*pi*W_m)$
- W_m/D_m
- $2*pi*D_m/W_m$
- C/C_c
- $(K/M)^{0.5}$

32. A car is running at a constant speed, which of the following is the feedback element for the driver?

- Clutch
- Eyes
- Needle of the speedometer
- Steering wheel
- None of these

33. Which cross-section is better for vibration damping?

- Rectangle
- Diamond
- I-section
- Circular
- Square

34. A Coulomb Friction Model has excitation frequency of 7 rad/s, displacement amplitude 1 m and excitation force amplitude of 44N. The equivalent viscous damping coefficient is

- 24 N-s/m
- 0.1 N-s/m
- 0.8 N-s/m
- 1 N-s/m
- 8 N-s/m

35. Find the correct fact about the creep recovery response in Maxwell model subjected to stress?

- The dashpot deforms immediately and later the spring deforms
- The dashpot and spring gets equally deformed
- The spring deforms immediately while the dashpot never deforms
- The spring deforms immediately followed by the dashpot
- Neither spring nor dashpot deforms

36. Find the odd couple related to composite manufacturing?

- Deborah Number : Characterize the fluidity of material
- Low Deborah Number : Material behaves like a solid
- High Deborah Number : More like a solid
- Low Deborah Number : Stress relaxation
- High Deborah Number : Creep

37. Find the wrong fact about Tan δ?

- δ ranges between 0^0 to 90^0
- As it approaches 0^0, it shows purely elastic behavior
- As it approaches 90^0, it shows purely viscous flow behavior
- As it approaches 45^0, it shows purely rubbery flow behavior
- Its value is maximum at the glass transition temperature

38. ACLD is

- Additional Constrained Layer Damping
- Active Carbon Layer Damping
- Adaptive Composite Layer Damping
- Active Constrained Level Damping
- Active Constrained Layer Damping

39. A Viscoelastic material may be modelled by

- Kelvin-Voight model
- Maxwell model
- Standard linear solid model
- Standard linear fluid model
- All are correct

40. Controllability is applicable for

- Tuned mass damper
- Active vibration control
- Dynamic vibration absorber
- Vibration neutralizer
- Auxiliary mass damping

Section III [8 Questions] - 5 marks/question

41. Which one of the following is not a fundamental way to control vibrations?

- Reduction at source
- Isolation
- Avoiding system modification
- Active vibration control
- Using response as a source of excitation and convert mechanical energy into electrical energy

42. What is the Displacement transmissibility of a SDOF system under base excitation in terms of damping ratio ζ and non-dimensional frequency ratio Ω? Is it the same as force transmissibility?

- $T = \sqrt{\frac{1+(2\zeta\Omega)^2}{(1-\Omega^2)^2+(2\zeta\Omega)^2}}$, No
- $T = \sqrt{\frac{(2\zeta\Omega)^2}{(1-\Omega^2)^2+(2\zeta\Omega)^2}}$, Yes
- $T = \sqrt{\frac{(2\zeta\Omega)^2}{(1-\Omega^2)^2+(2\zeta\Omega)^2}}$, No
- $T = \sqrt{\frac{1+(2\zeta\Omega)^2}{(1-\Omega^2)^2+(2\zeta\Omega)^2}}$, Yes
- $T = \sqrt{\frac{1+(2\zeta\Omega)^2}{(2\zeta\Omega)^2}}$, Yes

43. Fill in the Blanks for the following damping relationship

(i) Damping Ratio (ζ) = ... (in terms of system parameters 'k', 'm', 'c')

(ii) Loss Factor (η) = ... (in terms of ζ and Ω)

(iii) Logarithmic Decrement (δ) = ... (in terms of ζ , for small ζ)

The correct option is

- $\zeta = \frac{c}{2km}, \eta = 4\zeta\,\Omega, \delta = 2\,\pi\,\zeta$
- $\zeta = \frac{c}{2\sqrt{km}}, \eta = 2\zeta\,\Omega, \delta = 4\,\pi\,\zeta$
- $\zeta = \frac{c}{2\sqrt{km}}, \eta = 2\zeta\,\Omega, \delta = 2\pi\zeta$
- $\zeta = \frac{c}{2\sqrt{km}}, \eta = \zeta\,\Omega, \delta = 2\,\pi\,\zeta$
- $\zeta = \frac{c}{\sqrt{km}}, \eta = 2\zeta\,\Omega, \delta = 2\,\pi\,\zeta$

44. The plant of a vibrating system is given by

$$G(s)=\frac{1}{s^2+2\varsigma\omega_n s+\omega_n^2}$$

Find out the closed loop transfer function (CLTF) corresponding to unity feedback, proportional gain 'k', reference signal 'r' and output response 'c'. What change do you expect in the closed loop system?

- $\text{CLTF}=\frac{k}{s^2+2\zeta\omega_n s+s\omega_n^2+k}$, decrease in the stiffness and the fundamental frequency
- $\text{CLTF}=\frac{k}{s^2+2\zeta\omega_n s+\omega_n^2+sk}$, increase in the stiffness and the fundamental frequency
- $\text{CLTF}=\frac{k}{s^2+2\zeta\omega_n s+\omega_n^2+k}$, increase in the stiffness and the fundamental frequency
- $\text{CLTF}=\frac{k}{s^2+2\zeta\omega_n s+\omega_n^2+k}$, decrease in the stiffness and the fundamental frequency
- $\text{CLTF}=\frac{k}{s^2+2\zeta\omega_n+\omega_n^2+k}$, increase in the stiffness and the fundamental frequency

45. Consider an isolator for a single degree of freedom system having mass 'm' and complex stiffness 'k^*', which is subjected to harmonic base excitation of frequency 'ω'. Find out the force transmissibility at the base?

- $T=\left|\frac{k^*}{k^*-m\omega^2}\right|$
- $T=\left|\frac{2k^*}{k^*-m\omega^2}\right|$
- $T=\left|\frac{k^*}{2k^*-m\omega^2}\right|$
- $T=\left|\frac{k^*}{k^*-m\omega}\right|$
- $T=\left|\frac{k^*}{k^*-2m\omega^2}\right|$

46. A beam of mass 5 kg, length 1 m and width 0.1 m are specified. The thickness of the beam is free variable. What will be the figure of merit (FOM) in terms of modulus of elasticity 'E', loss factor 'η' and density 'ρ' such that the maximum velocity amplitude is minimum under a harmonic loading?

- $\text{FOM}=\eta\sqrt{\frac{2E}{\rho^3}}$
- $\text{FOM}=2\eta\sqrt{\frac{E}{\rho^3}}$
- $\text{FOM}=\eta\sqrt{\frac{E}{2\rho^3}}$
- $\text{FOM}=\eta\sqrt{\frac{E}{\rho^3}}$
- $\text{FOM}=\eta\sqrt{\frac{E}{3\rho^3}}$

47. The odd step that one should not follow for obtaining a complete solution to any vibration problem?

- Identify the source of vibration and characterize it
- Specify the level to which it should be reduced
- Select the appropriate method and prepare analytical design
- Realize the design in practice.
- Apply active vibration control everywhere as it is cheap.

48. State True or False.

(a) Both Solid and Annular Inserts are good for structural damping
(b) Half-power band width is used for obtaining damping ratio
(c) Detuning is important for active vibration control
(d) Waterbed effect is very common for constrained layer damping
(e) TMD is a special case of DVA

The correct option is

- (a): True, (b): False, (c): True, (d): True, (e): False
- (a): False, (b): False, (c): False, (d): True, (e): True
- (a): True, (b): True, (c): False, (d): True, (e): True
- (a): True, (b): False, (c): True, (d): True, (e): True
- (a): True, (b): True, (c): False, (d): False, (e): True