MOOC QP Set 2

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 625 N/m and mass 1 kg is subjected to an excitation of 0.1 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 1936 N/m, what should be the mass of the secondary system for harmonic excitation at 7 Hz to achieve perfect tuned condition?
   - 0.02 kg
   - 20 kg
   - 0.1 kg
   - 1 kg
   - 100 kg

3. Power spectral density function is important for the following case
   - To find out control gain for active vibration control
   - To characterize and control the source of vibration
   - To design constrained layer thickness
   - To find out the Strouhal number
   - To find out hysteretic damping coefficient

4. A vibrating system is dissipating energy at the rate of 0.02 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
   - 0.0002

5. In a hysteretic damping system, the α is 6.28 x 10^{-2}, the excitation frequency is 10 rad/sec the equivalent damping constant will be?

- 2 x 10^{-3}
- 0.01
- 3.14
- 31.4
- None of these

6. Why Baffle walls are used in Rocket Engine?

- for reducing the stress concentration
- for reducing sloshing of fluid
- for corrosion prevention
- for system modification
- for vibration isolation

7. The loss factor for a material whose loss modulus is ten times the storage modulus will be?

- In the range of 0.1 to 5 GPa
- 1
- 200 to 500 GPa
- 10
- None of these

8. Locking frequency is the

- Natural frequency of the combined system when the absorber mass is rigidly connected to primary mass.
- Natural frequency of the combined system when the absorber mass is isolated from primary mass.
- Natural frequency of the combined system when the absorber mass is minimizing vibration of primary mass.
- Natural frequency of the combined system when the absorber mass is maximizing vibration of primary mass.
- None of these

9. A Hand-held hair cutter has 75 Hz 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 75 Hz natural frequency

10. Proof mass actuator is basically

- A TMD
- A Stockbridge Damper
- An AMD
- An active DVA
- None of these

11. Active Vibration Control does not require

- Sensor
- Actuator
- High damping material
- Power Amplifier
- Microprocessor

12. Find the incorrect statement

- Spillover is unavoidable for active vibration control
- Distributed Control may avoid spill-over
- The chance of spill-over is high in continuous system
- Notch controller is designed for resisting spill-over to a specific frequency
- Detuning is a type of spill-over controller

13. Find the correct flow in Feed Forward Active Vibration control

- Reference, Comparison with sensing, Controller, Actuator, Vibrating body, Sensor, Comparator
- Reference, Adaptive filter, Comparator, Vibrating body, Sensor
- 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 controller

- Transient Response
- Steady state error
- Stability
- Plant type
- All of the given factors

15. What is not true about Vortex induced vibration?

- It is not associated with flutter
- 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 can have catastrophic consequence

16. Equivalent Viscous Damping Coefficient for linear hysteretic materials

- inversely proportional to square of the excitation frequency
- directly proportional to excitation frequency
- inversely proportional to excitation frequency
- directly proportional to square of the excitation frequency
- None of these

17. What is the correct set of parameter for Kelvin-Voight Model in terms of Standard Linear Solid Model?

- $[a_0=1, a_1 = 1, b_0=E, b_1=0]$
- $[a_0=0, a_1 = 0, b_0=E, b_1=\eta]$
- $[a_0=1, a_1 = 0, b_0=E, b_1=\eta]$
- $[a_0=1, a_1 = 0, b_0=E, b_1=0]$
- None of the options

18. Which one is related to Belleville spring?

- Vibration Isolation
- Piston force generation
- Satellite Deployment
- Constrained Layer Damping
- All are correct

19. Find the odd one?

- Pneumatic Suspension : Kinetic Energy
- Torsional Spring : Potential Energy
- DVA : Damping
- Thermal Energy : Heat Pipe
- Acoustic Energy : Muffler

20. Multi-nozzle Jet exit creates

- Low frequency large eddy
- Low frequency small eddy
- High frequency small eddy
- High frequency large eddy
- High frequency laminar flow

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
- Mechanical assembly
- Transmission power line vibration
- Vibration of payload during rocket launching

22. Self-excited chatter is

- Originated from fluid-structure interaction
- A type of vortex induced vibration
- An outcome of brain-machine interaction
- A case of friction driven oscillation
- A case of vibration neutralization

23. A flexible submerged pipe across a stream is most likely to fail due to

- Periodic variation in water speed
- Periodic variation of lift force
- Moisture and corrosion
- Secondary creep
- None of the above

24. Find the incorrect statement?

- A Beam with Fixed-Fixed Boundary Condition will have higher natural frequency than Fixed-free Condition
- Half-power point technique is used for damping evaluation
- Modulus of Elasticity of Viscoelastic material is complex
- Critical frequency and glass transition temperature are related to viscoelastic material
- KV model can predict stress relaxation better than Maxwell model

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

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

26. Consider the Kelvin-Voight model of a viscoelastic isolator. The following properties are provided: Stiffness = 100 N/m, Damping = 10 N-s/m, Mass = 4 kg, Excitation frequency = 10 rad/s. Find the complex stiffness?

- 10(1+j)
- 10(1+10j)
- 100(10+10j)
- 100(1-10j)
- 100(1+j)

27. A simple unity feedback closed loop control system has the following parameters. K = 35, G = $10/(5s^2+10)$. The closed loop transfer function will be?

- $70/(s+70)$
- $35/(s^2+70)$
- $70/(s^2+35)$
- $70/ (s^2+ 72)$
- $35/(5s^2+10)$

28. Which is true in the case of structural hysteresis of elliptic shape?

- n = 1
- n = 10
- n = 0.1
- n = 1.414
- n = 2

29. Find out the odd couple?

- Self-Tuned Pendulum : Vibration Absorber
- System Modification : Baffle Wall
- Suspension Design : Pneumatic system
- Steward Platform : Passive Vibration Control
- Tuned Mass Damper : Vibration neutralizer

30. In a Viscous damping model, displacement = 10mm, C = 7N-s/m, excitation frequency = 100 rad/s. Find out the energy dissipated per cycle?

- 0.22 J
- 2.2 J
- 700 J
- 70 J
- None of these

31. What is the correct expression of specific damping energy in multi-axial loading?

- $J(\sigma_{eq}^2)^{n/2}$
- C $(\sigma_{eq}^2)^{n/2}$
- 2*pi*D_m/W_m
- C/$(\sigma_{eq}^2)^{n/2}$
- $(K/M)^{0.5}$

32. The principal stresses on a cube are 20 MPa, 20 MPa and 10 MPa respectively, the modulus of elasticity is 50 MPa and Poisson's ratio is 0.5. The maximum elastic energy per unit volume will be?

- 2
- 1
- 3
- 4
- 5

33. For a structural damping case of a diamond shaped beam with n = 4, the shape factor is

- 0.1
- 0.2
- 0.3
- 0.4
- 1.0

34. The loss factor for a viscoelastic material is 0.7 and it is used over a vibrating beam as an unconstrained layer. Neglect extensional stiffness of the viscoelastic material. Also neglect all higher terms of thickness ratio. Then, for a thickness ratio of 2 and modulus ratio of 3, the overall loss factor will be approximately?

- 0.1
- 4.2
- 0.6
- 1.0
- 12

35. Find the incorrect fact about the Constrained Layer Damping?

- It is more effective than free layer damping
- The constrained layer is always sandwiched between the two layers
- It is based on the fact that shear damping is more than extensional damping
- The overall loss factor directly varies with shear factor
- The shear factor is directly proportional to the storage modulus of the viscoelastic material

36. Find which one is not related to DVA?

- Proof Mass Actuator
- Free Layer Damper
- Stock-bridge Damper
- Auxiliary Mass Damper
- Vibration Neutralizer

37. A Material has loss modulus 10 GPa and Storage Modulus of 100 GPa. The value of Tan δ is

- 0.01
- 10
- 45
- 0.1
- 1

38. Piezoelectric Material can be used in

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

39. Amplification of CLD is possible by

- Corrugated Construction
- Sandwich Construction
- High Loss Modulus
- Corrugated Construction and High Loss Modulus
- All are correct

40. Rattle space is not 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 are types of SISO control?

- Feedback, Feed-forward, Hybrid, Distributed
- Feedback, Distributed, Hybrid, Notch
- Feedback, Feed-forward, Hybrid, Notch
- Feedback, MIMO, Hybrid, Notch
- Feedback, Feed-forward, Distributed, Notch

42. What is the Displacement Transmissibility of a SDOF system under base excitation if the damping ratio is the same as for critical damping and the non-dimensional frequency ratio Ω = 1? Is it same as force transmissibility?

- $T = \sqrt{\frac{1}{4}}$, No
- $T = 1$, Yes
- $T = \sqrt{\frac{4}{5}}$, No
- $T = \sqrt{\frac{5}{4}}$, Yes
- $T = \sqrt{\frac{3}{4}}$, Yes

43. Judge the facts for springs as True or False?

(a) Helical spring is good for low frequency isolation
(b) Transversely loaded spring has low load bearing capacity
(c) Slotted Spring has low stiffness but high accuracy
(d) Non-linear springs may have super harmonic vibration
(e) Belleville springs have similar applications like slotted spring

The correct option is

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

44. The plant of a vibrating system is given by

$$G(s) = \frac{1}{(s + j\omega_d)(s - j\omega_d)}$$

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?

- $CLTF = \frac{k}{s^2+\omega_d^2+sk}$, decrease in the stiffness and the fundamental frequency
- $CLTF = \frac{k}{s^2+j\omega_d^2+k}$, increase in the stiffness and the fundamental frequency
- $CLTF = \frac{k}{s^2+\omega_d^2+k}$, increase in the stiffness and the fundamental frequency
- $CLTF = \frac{k}{s^2+\omega_d^2+jk}$, decrease in the stiffness and the fundamental frequency
- $CLTF = \frac{jk}{s^2+\omega_d^2+k}$, increase in the stiffness and the fundamental frequency

45. The mass of a proof mass actuator = 1 kg. It can produce displacement amplitude of 1 cm. The force it can deliver in the frequency domain is given by?

- $F = -(\frac{s^2}{100})$
- $F = (\frac{s^2}{100})$
- $F = (\frac{s^2}{10})$
- $F = |-100s|$
- $T = |-10s|$

46. A beam of mass 10 kg, length 2m 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?

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

47. The Eigen values of a system are -1 and -2 respectively. What is the Characteristic Polynomial? Is the system stable?

- S-2, Yes
- S-1, Yes
- S^2+2, No
- S^2+ 3S+2, Yes
- S^2+2, Yes

48. State True or False?

(a) High stress concentration is good for structural damping
(b) Half-power Band width is used for obtaining mass ratio
(c) Detuning is important for vibration reduction at source
(d) Waterbed effect is very common for active damping system
(e) AMD is a special case of TMD

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): False, (c): False, (d): True, (e): False