

# Advanced Mechanical Engineering Principles

Mechanical Engineering · Practice Test · 18 Questions

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**1. In the context of the Buckingham Pi theorem, which of the following is the correct definition of the number of dimensionless groups (pi terms) required to describe a physical system?**

- A) The number of independent variables minus the number of fundamental dimensions
- B) The number of fundamental dimensions minus the number of independent variables
- C) The total number of variables minus the number of fundamental dimensions
- D) The product of fundamental dimensions and independent variables

**2. What is the physical significance of the Biot number (Bi) in transient heat conduction problems?**

- A) Ratio of convective heat transfer to radiative heat transfer
- B) Ratio of internal conductive resistance to external convective resistance
- C) Ratio of inertial forces to viscous forces
- D) Ratio of thermal diffusivity to kinematic viscosity

**3. According to the Griffith criterion for brittle fracture, the critical stress required for fracture propagation is inversely proportional to which of the following?**

- A) The square root of the crack length
- B) The square of the crack length
- C) The modulus of elasticity
- D) The Poisson ratio

**4. For a Newtonian fluid in laminar flow through a circular pipe, what is the ratio of maximum velocity to average velocity?**

- A) 1.0
- B) 1.5
- C) 2.0
- D) 2.5

**5. In thermodynamics, what is the mathematical definition of the Joule-Thomson coefficient ( $\mu_{JT}$ )?**

- A)  $(\partial h / \partial P)_T$
- B)  $(\partial T / \partial P)_h$
- C)  $(\partial P / \partial T)_v$
- D)  $(\partial T / \partial v)_P$

**6. Which crystal structure exhibits the highest number of slip systems, thereby typically demonstrating the greatest ductility in metals?**

- A) Body-Centered Cubic (BCC)
- B) Face-Centered Cubic (FCC)
- C) Hexagonal Close-Packed (HCP)
- D) Simple Cubic (SC)

**7. What does the Strouhal number represent in fluid dynamics?**

- A) The ratio of buoyancy forces to inertial forces
- B) The dimensionless frequency of vortex shedding
- C) The ratio of pressure forces to surface tension
- D) The compressibility of a fluid flow

**8. In a four-bar linkage mechanism, Grashof's law states that at least one link can perform a full revolution if:**

- A)  $S + L \leq P + Q$
- B)  $S + L > P + Q$
- C)  $S + P > L + Q$
- D)  $S + Q < L + P$

**9. What is the primary physical phenomenon described by the Navier-Stokes equations?**

- A) Conservation of angular momentum in rigid bodies
- B) Motion of viscous fluid substances
- C) Distribution of stress in hyper-elastic materials
- D) Propagation of elastic waves in solids

**10. Which thermodynamic cycle is the theoretical limit for an internal combustion engine utilizing spark ignition?**

- A) Brayton cycle
- B) Diesel cycle
- C) Otto cycle
- D) Rankine cycle

**11. What is the relationship between the shear modulus (G), Young's modulus (E), and Poisson's ratio (?) for an isotropic material?**

- A)  $G = E / (2(1 - ?))$
- B)  $G = E / (2(1 + ?))$
- C)  $G = E * (1 + 2?)$
- D)  $G = E / (1 - ?^2)$

**12. In the context of beam theory, the Euler-Bernoulli equation assumes that:**

- A) Plane sections remain plane and perpendicular to the neutral axis
- B) Shear deformations are significant for long beams
- C) The material behaves non-linearly
- D) Rotary inertia is the dominant factor

**13. The Nusselt number (Nu) represents the ratio of:**

- A) Convective heat transfer to conductive heat transfer
- B) Thermal diffusivity to momentum diffusivity
- C) Kinematic viscosity to thermal diffusivity
- D) Total heat flux to radiative heat flux

**14. Which failure theory is most appropriate for predicting the yielding of ductile materials under multiaxial stress states?**

- A) Rankine theory
- B) Tresca yield criterion
- C) Coulomb-Mohr theory
- D) Goodman criterion

**15. In gas dynamics, what is the Mach number (M) defined as?**

- A) The ratio of the speed of an object to the speed of light
- B) The ratio of flow velocity to the local speed of sound
- C) The ratio of inertial force to gravitational force
- D) The ratio of pressure to density

**16. Which dimensionless number relates the inertial forces to the viscous forces in a fluid flow?**

- A) Prandtl number
- B) Reynolds number
- C) Schmidt number
- D) Grashof number

**17. What is the primary function of an involute gear profile?**

- A) To minimize the sliding velocity between teeth
- B) To ensure a constant angular velocity ratio
- C) To increase the number of teeth in contact
- D) To reduce the heat generated during power transmission

**18. In metallurgy, what is the process of 'quenching' primarily used to achieve?**

- A) Increase ductility by slowing cooling
- B) Form martensite by rapid cooling from the austenite phase
- C) Decrease hardness to improve machinability
- D) Remove internal stresses through controlled heating