

ENTRANCE EXAMINATION FOR ADMISSION, MAY 2011.

Ph.D. (MECHANICAL ENGINEERING)

COURSE CODE : 139

Register Number :

*Signature of the Invigilator
(with date)*

COURSE CODE : 139

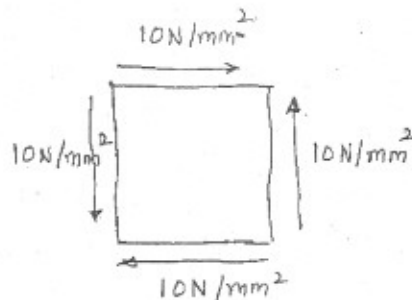
Time : 2 Hours

Max : 400 Marks

Instructions to Candidates :

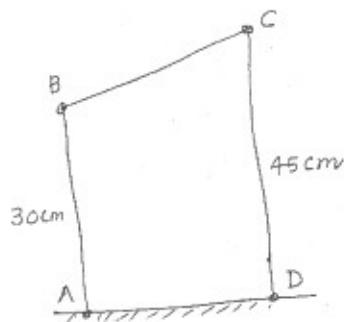
1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.
2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.
3. Read each question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.
4. Avoid blind guessing. A wrong answer will fetch you -1 mark and the correct answer will fetch 4 marks.
5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.
6. Do not open the question paper until the start signal is given.
7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.
8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.
9. Use of Calculators, Tables, etc. are prohibited.

- A solid shaft can resist a bending moment of 3.0 KNm and a twisting moment of 4.0 KNm together, then the maximum torque that can be applied is
 (A) 7.0 KNm (B) 3.5 KNm (C) 4.5 KNm (D) 5.0 KNm
- Principal stress at a point in a plane stressed elements are $\sigma_x = \sigma_y = 500 \text{ kg/cm}^2$. Normal stress on the plane inclined at 45° to x axis will be
 (A) 0 (B) 500 kg/cm^2 (C) 707 kg/cm^2 (D) 1000 kg/cm^2
- If the value of Poisson's ratio is zero, then it means that
 (A) the material is rigid
 (B) the material is perfectly plastic
 (C) there is no longitudinal strain in the material
 (D) none of the above
- A circular shaft can transmit a torque of 5 KNm. If the torque is reduced to 4 KNm, then the maximum value of bending moment that can be applied to the shaft is
 (A) 1 KNm (B) 2 KNm (C) 3 KNm (D) 4 KNm
- The "Euler" load for a column is 100 kN and crushing load is 1500 kN. The Rankine load is equal to
 (A) 600 kN (B) 1000 kN (C) 1500 kN (D) 2500 kN
- The state of stress at a point in a stressed element is shown in the given figure. The maximum tensile stress in the element will be



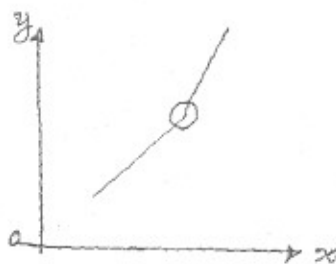
- (A) 20 N/mm^2 (B) $10\sqrt{2} \text{ N/mm}^2$ (C) 10 N/mm^2 (D) Zero
- Maximum size of a fillet weld for a plate of square edge is
 (A) 1.5 mm less than that of the thickness of the plate
 (B) one half of the thickness of the plate
 (C) thickness of the plate itself
 (D) 1.5 mm more than the thickness of the plate

8. The ratio between the stress produced in a bar by a sudden application of load (impact loading) as compared to the stress produced by the gradual application of same load is
 (A) 1.5 (B) 2.0 (C) 2.5 (D) 3.0
9. The diameter of a rivet connecting plate of thickness 't' in 'mm' is given by Unwin's formula as
 (A) $d = 6.5\sqrt{t}$ (B) $4.05\sqrt{t} = d$ (C) $d = 1.9\sqrt{t}$ (D) $d = 1.5\sqrt{t}$
10. When a closely coiled helical spring is subjected to an axial load, the deflection of the spring is directly proportional to
 (A) Modulus of rigidity of the spring material
 (B) Diameter of the spring wire
 (C) Mean diameter of the spring
 (D) Number of turns of the spring
11. Quick return mechanism is an inversion of
 (A) four bar chain (B) single slider crank chain
 (C) double slider crank chain (D) crossed slider crank chain
12. In the reciprocating engines primary forces
 (A) are completely balanced (B) are partially balanced
 (C) are balanced by secondary forces (D) cannot be balanced
13. ABCD is a four bar mechanism in which $AB = 30$ cm and $CD = 45$ cm AB and CD are both perpendicular to fixed link AD, as shown in fig. If velocity of B at this condition is V then velocity of C is



- (A) V (B) $\frac{3}{2}V$ (C) $\frac{9}{4}V$ (D) $\frac{2}{3}V$

14. A friction circle is a circle drawn when the journal rotates in a bearing. Its radius depends on the coefficient of friction and
- (A) magnitude of the forces on the journal
 (B) angular velocity of the journal
 (C) clearance between the journal and the bearing
 (D) radius of the journal
15. In involute gears, the pressure angle is
- (A) dependent on the size of the teeth
 (B) dependent on the size of gears
 (C) always constant
 (D) always variable
16. In a multiple V belt drive, when a single belt is damaged, it is preferable to change the complete set to
- (A) reduce vibration
 (B) reduce slip
 (C) ensure uniform loading
 (D) ensure proper alignment
17. The two line system, shown in the fig. is constrained to move with planer motion. It possesses

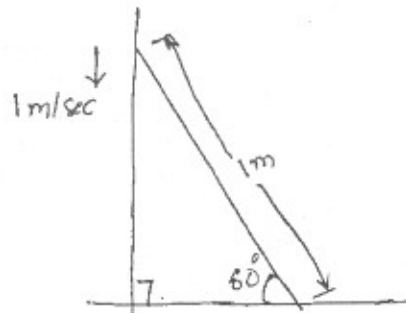


- (A) 2 degrees of freedom
 (B) 3 degrees of freedom
 (C) 4 degrees of freedom
 (D) 6 degrees of freedom
18. A fixed gear having 100 teeth meshes with another gear having 25 teeth, the centre lines of both the gears being joined by an arm so as to form an epicyclic gear train. The number of rotations made by the smaller gear for one rotation of the arm is
- (A) 3
 (B) 4
 (C) 5
 (D) 6
19. For a spring controlled governor to be stable, the controlling force (F) is related to the radius (r) by the equation
- (A) $F = ar - b$
 (B) $F = ar + b$
 (C) $F = ar$
 (D) $F = \frac{a}{r} + b$

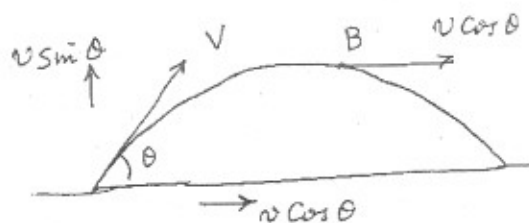
20. The gear train usually employed in clocks is a
 (A) reverted gear train (B) simple gear train
 (C) sum and planet gear (D) differential gear
21. Total pressure on 1 m × 1 m gate immersed vertically at a depth of 2 m below the free water surface will be
 (A) 1000 kg (B) 2000 kg (C) 4000 kg (D) 8000 kg
22. Cavitation is caused by
 (A) high velocity (B) low barometric pressure
 (C) high pressure (D) low pressure
23. For an irrotational flow the equation $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2}$ is known as
 (A) Bernouli's equation (B) Cauchy Riemann's equation
 (C) Euler's equation (D) Laplace equation
24. The magnitude of water hammer depends on the
 (A) length of pipeline
 (B) speed at which the valve is closed
 (C) elastic properties of the liquid flowing through the pipe and pipe material
 (D) all of the above
25. Thickness of laminar boundary layer at a distance x from the leading edge over flat plate varies as
 (A) x (B) x^2 (C) $x^{1/2}$ (D) $x^{4/5}$
26. Process of diffusion of one liquid into other through a semi-permeable membrane is called
 (A) Viscosity (B) Osmosis (C) Surface tension (D) Cohesion
27. Friction drag is generally larger than the pressure drag in
 (A) flow past a sphere (B) flow past a cylinder
 (C) flow past an air foil (D) flow past a thin sheet
28. If V is the mean velocity of flow, then according to Darcy-Weisbach equation for pipe flow, energy loss over a length of pipe is proportional to
 (A) V (B) $\frac{1}{V}$ (C) V^2 (D) \sqrt{V}

29. Continuity equation for an incompressible fluid is
- (A) $A_1 V_1 = A_2 V_2$ (B) $\rho_1 A_1 V_1 = \rho_2 A_2 V_2$
 (C) $\frac{A_1 V_1}{\rho_1} = \frac{A_2 V_2}{\rho_2}$ (D) $\frac{\rho_1 A_1}{V_1} = \frac{\rho_2 A_2}{V_2}$
30. Component of the force of fluid on the body (which is generally inclined to the direction of motion of the body) parallel to the direction of motion is called
- (A) drag (B) lift (C) wake (D) thrust
31. A block of mass 5 kg is thrust up a 30° inclined plane with an initial velocity of 4 m/sec. It travels a distance of 1.0 m before it comes to rest. The force of friction acting on it would be
- (A) 4 (B) 5 (C) 15.5 (D) 6
32. A solid cylinder of mass ' m ' and radius ' r ' starts rolling from rest along an inclined plane. If it rolls without slipping from a vertical height ' h ', the velocity of its centre of mass when it reaches the bottom is
- (A) $\frac{2}{3}\sqrt{2gh}$ (B) $\sqrt{2gh}$ (C) \sqrt{gh} (D) $\sqrt{5gh}$
33. A ball 'A' of mass m falls under gravity from a height of h and strikes another ball B of mass m which is supported at rest on a spring of stiffness ' k '. Assume perfectly elastic impact. Immediately after the impact
- (A) velocity of ball A is $\frac{1}{2}\sqrt{2gh}$ (B) the velocity of ball A is zero
 (C) the velocity of both balls is $\frac{1}{2}\sqrt{2gh}$ (D) the velocity of ball B is zero
34. A wheel of mass m and radius r is in accelerated rolling motion without slip under a steady axle torque T . If the coefficient of kinetic friction is μ , the friction force from the ground on the wheel is
- (A) μmg (B) $\frac{T}{r}$
 (C) Zero (D) None of the above

35. A rod of length 1 m is sliding in a corner as shown in the fig. At an instant when the rod makes an angle of 60 degrees with the horizontal plane, the velocity of point A on the rod is 1 m/sec. The angular velocity of the rod at this instant

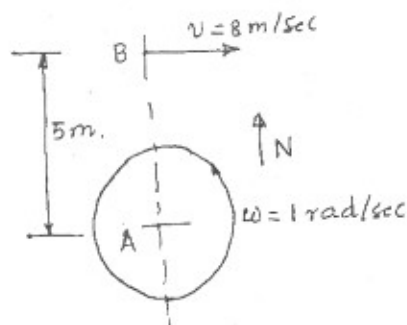


- (A) 2 rad/sec (B) 1.5 rad/sec (C) 0.5 rad/sec (D) 0.75 rad/sec
36. A car moving with uniform acceleration covers 450 m in a 5 second interval and covers 700 m in the next 5 second interval. The acceleration of the car is
- (A) 7 m/sec² (B) 50 m/sec² (C) 25 m/sec² (D) 10 m/sec²
37. A steel wheel of 60 mm diameter rolls on a horizontal steel rail. It carries a load of 500 N. The coefficient of rolling resistance is 0.3 mm. The force in N, necessary to roll the wheel along the rail is
- (A) 0.5 (B) 5 (C) 15 (D) 150
38. A block of steel is loaded by a tangential force on the top surface while the bottom surface is held rigidly. The deformation of the block is due to
- (A) shear only (B) bending only
(C) shear and bending (D) torsion
39. A shell is fired from a cannon with a speed v at an angle θ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of pieces retraces its path to the cannon. The speed of the other piece immediately after explosion is



- (A) $3v \cos \theta$ (B) $2v \cos \theta$ (C) $\frac{3}{2}v \cos \theta$ (D) $\sqrt{\frac{3}{2}}v \cos \theta$

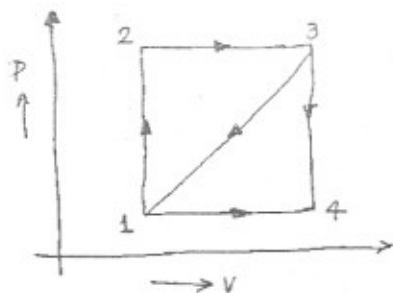
40. As shown in the fig. a person A is standing at the centre of a rotating platform facing person B who is riding a bicycle, heading East. The relevant speeds and distances are shown in Fig. a person, a bicycle heading East. At the instant under consideration, what is the apparent velocity of B as seen by A?



- (A) 3 m/sec heading East (B) 3 m/sec heading West
 (C) 8 m/sec heading East (D) 13 m/sec heading East
41. The wavelength of the radiation emitted by a body depends upon
 (A) the nature of its surface (B) the area of its surface
 (C) the temperature of its surface (D) all the above factors
42. Provision of fins on a given heat transfer surface will be more if there are
 (A) fewer number of thin fins (B) fewer number of thick fins
 (C) large number of thin fins (D) large number of thick fins
43. In a heat exchanger with one fluid evaporating or condensing the surface area required to least in
 (A) parallel flow (B) counter flow
 (C) cross flow (D) same in all above
44. A furnace is made of a red brick wall of thickness 0.5 m and conductivity 0.7 W/mK. For the same heat loss and temperature drop, this can be replaced by a layer of diatomite earth of conductivity 0.14W/mK and thickness
 (A) 0.5 m (B) 0.1 m (C) 0.2 m (D) 0.3 m
45. For evaporators and condensers, for the given conditions, the Logarithmic Mean Temperature Difference (LMTD) for parallel flow is
 (A) equal to that of counter flow
 (B) greater than that for counter flow
 (C) smaller than that for counter flow
 (D) very much smaller than that for counter flow

46. The thickness of thermal and hydrodynamic boundary layer is equal if ($Pr =$ Prandtl number, $Nu =$ Nusselt Number)
- (A) $Pr = 1$ (B) $Pr > 1$ (C) $Pr < 1$ (D) $Pr = Nu$
47. In a counter flow heat exchanger, cold fluid enters at 30°C and leaves at 50°C whereas the hot fluid enters at 15°C and leaves at 130°C . The mean temperature difference for this case is
- (A) Indeterminate (B) 20°C (C) 80°C (D) 100°C
48. Heat is mainly transferred by conduction, convection and radiation in
- (A) insulated pipes carrying hot water
 (B) refrigerator freezer coil
 (C) boiler furnaces
 (D) condensation of steam in a condenser
49. In radiative heat transfer, a gray surface is one
- (A) which appear gray to the eye
 (B) whose emissivity is independent of wavelength
 (C) which has reflectivity equal to zero
 (D) which appears equally bright from all directions
50. Which surface will have the least emissivity?
- (A) Smooth glass (B) Plaster (C) Aluminium foil (D) Concrete
51. For a closed system, difference between the heat added to the system and work done by the gas, is equal to the change in
- (A) enthalpy (B) entropy (C) internal energy (D) temperature
52. Which of the following is not an extensive property of a thermodynamic system?
- (A) total mass (B) total internal energy
 (C) total volume (D) temperature
53. The measurement of thermodynamic property known as temperature is based on
- (A) Zeroth law of thermodynamics (B) First law of thermodynamics
 (C) Second law of thermodynamics (D) None of the above
54. The difference between two specific heats, $C_p - C_v = \frac{R}{J}$. This relation is valid for
- (A) ideal gases (B) perfect gases (C) real gases (D) pure gases

55. The condition for reversibility of a cycle is
- (A) cyclic $\int \frac{d\theta}{T} < 0$ (B) cyclic $\int \frac{d\theta}{T} > 0$
 (C) cyclic $\int \frac{dQ}{T} = 0$ (D) cyclic $\int \frac{dQ}{T} \neq 0$
56. For the same compression ratio, the efficiency of dual combustion cycle as compared to otto cycle is
- (A) more (B) less
 (C) equal (D) none of the above
57. A refrigerator with its door open is left running in a closed room. If the fan is also on and heat transfer from the room is negligible the room temperature will
- (A) fall or some time and then rise (B) keep on increasing
 (C) decrease continuously (D) remain unaffected
58. The reading of the pressure gauge fitted on a vessel is 25 bar. The atmospheric pressure is 1.03 bar and the value of g is 9.81 m/sec^2 . The absolute pressure in the vessel is
- (A) 23.97 Bar (B) 25.00 Bar (C) 26.03 Bar (D) 34.84 Bar
59. Given that the path 1-2-3 a system absorbs 100 kJ and heat and does 60 kJ work while along the path 1-4-3 it does 20 kJ work (see the fig.). The heat absorbed during the cycle 1-4-3 is



- (A) -140 kJ (B) -80 kJ (C) -40 kJ (D) +60 kJ
60. In a cyclic heat engine operating between a source temperature of 600°C and a sink temperature of 20°C . The least rate of heat rejection per KW net output of the engine is
- (A) 0.460 KW (B) 0.505 KW (C) 0.588 KW (D) 0.650 KW
61. Device used to generate and supply steam at a high pressure and temperature is known as
- (A) steam injector (B) steam boiler
 (C) steam turbine (D) steam condenser

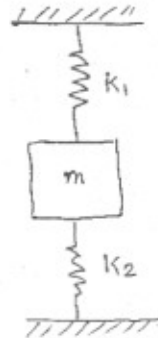
62. Boiler suitable for fluctuating demand of steam is
 (A) Lancashire boiler (B) Cornish boiler
 (C) Locomotive boiler (D) Cochran boiler
63. If combustion takes place inside the boiling water region, the boiler is known as
 (A) Natural circulation boiler (B) Forced circulation boiler
 (C) Internally fired boiler (D) Externally fired boiler
64. Safety valve generally used on high pressure boiler is
 (A) lever type (B) dead weight type
 (C) spring type (D) none of the above
65. A device, in which some portion of waste heat of flue gases is recovered to heat the air before it passes into the furnace for combustion purpose is known as
 (A) super heater (B) air preheater
 (C) injector (D) economiser
66. For the same length of stroke and speed of crankshaft, piston speed for a double acting steam engine as compared to piston speed of single acting steam engine is
 (A) equal (B) twice (C) four times (D) five times
67. Diagram factor is the ratio of
 (A) area of the actual indicator diagram to the area of theoretical indicator diagram
 (B) actual work done per stroke to the theoretical work done per stroke
 (C) actual mean effective pressure to the theoretical mean effective pressure
 (D) area of the theoretical indicator to the area of actual indicator diagram
68. In a receiver type compound steam engine, the high pressure and low pressure cylinders
 (A) have common piston rod (B) are set at 90°
 (C) have separate piston rods (D) are set in V-arrangement
69. When steam after doing work in the cylinder passes into a condenser, the engine is known as
 (A) condensing steam engine (B) non-condensing steam engine
 (C) vertical steam engine (D) reciprocating steam engine

70. In reaction turbine, when steam flows through the fixed blades
- (A) pressure and velocity both increases
 - (B) pressure and velocity both decreases
 - (C) pressure decreases, while velocity increases
 - (D) pressure increases, while velocity decreases
71. At the same speed, the number of power stroke given by a two-stroke cycle engine as compared to a four stroke cycle engine is
- (A) half
 - (B) same
 - (C) double
 - (D) four times
72. In a four stroke cycle petrol engine, the pressure inside the engine cylinder during suction stroke is
- (A) above the atmospheric pressure
 - (B) below the atmospheric pressure
 - (C) at the atmospheric pressure
 - (D) none of the above
73. In a petrol engine, mixture has the lowest pressure at the
- (A) beginning of the suction stroke
 - (B) end of the suction stroke
 - (C) end of the compression stroke
 - (D) beginning of the compression stroke
74. Three engines A, B and C operating at carnot engine use working substances as oxygen, hydrogen and air respectively, which engine will have higher efficiency
- (A) Engine A
 - (B) Engine B
 - (C) Engine C
 - (D) All engines have same efficiency
75. Out of the following diesel engines, the minimum air consumption per BHP will be in
- (A) 4 stroke, mechanical injection type
 - (B) 4 stroke, air injection type
 - (C) 2 stroke, mechanical injection type with pump scavenging
 - (D) 2 stroke, air injector type
76. For higher volumetric efficiency in SI engines
- (A) the proportion of the residual exhaust gases should be high
 - (B) the diameter of the inlet valve should be small
 - (C) the exhaust valve diameter should be large
 - (D) shape of piston crown should permit larger port area

77. An Otto cycle operates with volumes of 40 cm^3 and 400 cm^3 at Top Dead Centre (TDC) and Bottom Dead Centre (BDC) respectively. If the power output is 100 kW, what is the heat input in kW/sec.? Assume $r = 1.4$.
- (A) 166 (B) 145 (C) 110 (D) 93
78. In internal combustion engines, the approximate percentage of the combustion heat that passes to the cylinder walls is nearly
- (A) 5% (B) 10% (C) 25-30% (D) 45-50%
79. For minimising knocking tendency in SI engines, the spark plug should be located
- (A) near the inlet valve
 (B) away from the inlet valve
 (C) near the exhaust valve
 (D) midway between inlet and exhaust valve
80. For the same output and same compression ratio, four stroke SI engine as compared to two stroke engine will have
- (A) higher fuel consumption (B) higher fuel temperature
 (C) lower thermal efficiency (D) higher thermal efficiency
81. Stress concentration in cyclic loading is more serious in
- (A) ductile materials (B) brittle materials
 (C) ferrous materials (D) non-ferrous materials
82. The key will fail in which of the following manner?
- (A) shearing (B) crushing
 (C) both crushing and shearing (D) tearing
83. Which of the following bearing is suitable for fluctuating demands?
- (A) Needle roller bearing (B) Ball bearing
 (C) Tapered bearing (D) Cylindrical bearing
84. Backlash in spur gear is the
- (A) difference between the dedendum of one gear and the addendum of the mating gear
 (B) difference between the tooth space of the gear and the tooth thickness of the mating gear measured on the pitch circle
 (C) intentional extension of centre distance between two gears
 (D) difference between the addendum and the module

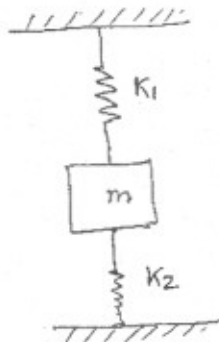
85. When the belt is stationary, it is subjected to some tension, known as initial tension. The value of this tension is equal to the
- (A) tension in the tight side of the belt
 - (B) tension in the slack side of the belt
 - (C) sum of the tensions in the tight side and slack side of the belt
 - (D) average tension of the tight side and slack side of the belt
86. A friction circle is drawn when a journal rotates in bearing. Its radius depends on the coefficient of friction and the
- (A) magnitude of the forces on the journal
 - (B) angular velocity of the journal
 - (C) clearance between the journal and the bearing
 - (D) radius of the journal
87. The bearing characteristic number in a hydro dynamic bearing depends on
- (A) length, width and load
 - (B) length, width and speed
 - (C) viscosity, speed and load
 - (D) viscosity, speed and bearing pressure
88. A transmission shaft subjected to bending loads must be designed on the basis of
- (A) maximum normal stress theory
 - (B) maximum shear stress theory
 - (C) maximum normal stress and maximum shear stress theories
 - (D) fatigue strength
89. In a belt-drive if the pulley diameter is doubled keeping the tension and belt width constant, then it will be necessary to
- (A) increase the key length
 - (B) increase the key depth
 - (C) increase the key width
 - (D) decrease the key length
90. The most suitable bearing for carrying very heavy loads with slow speed is
- (A) hydrodynamic bearing
 - (B) ball bearing
 - (C) roller bearing
 - (D) hydrostatic bearing

91. The equation $\frac{d^2x}{dt^2} + \frac{K}{m}x = 0$ represents
- (A) free vibrations
 (B) forced vibrations
 (C) periodically forced vibrations
 (D) free vibrations with viscous damping
92. For a vibrating system as the value ω/ω_n increases above unity, the amplification factor, irrespective of the value of damping factor has tendency to move towards
- (A) above unity
 (B) near unity
 (C) near infinity
 (D) near zero value
93. Ratio of two successive oscillations in an under damped system is
- (A) constant
 (B) linear
 (C) logarithmic
 (D) exponential
94. The natural frequency of the spring shown in fig. will be



- (A) $f_n = \frac{1}{2\pi} \sqrt{\frac{K_1 K_2}{m(K_1 + K_2)}}$
 (B) $f_n = \frac{1}{2\pi} \sqrt{\frac{K_1 + K_2}{m(K_1 K_2)}}$
 (C) $f_n = \frac{1}{2\pi} \sqrt{\frac{K_1 + K_2}{m}}$
 (D) $f_n = \frac{1}{2\pi} \sqrt{\frac{m K_1 K_2}{K_1 + K_2}}$

95. The equivalent spring stiffness given in the figure will be



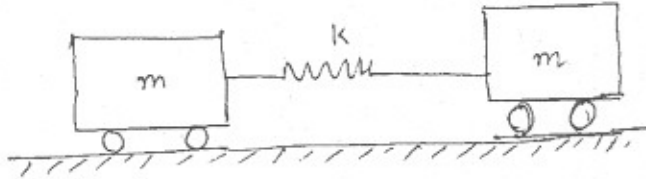
- (A) $\frac{K_1 K_2}{K_1 + K_2}$
 (B) $K_1 + K_2$
 (C) $\frac{1}{K_1 + K_2}$
 (D) $\frac{K_1 + K_2}{K_1 K_2}$

96. For lightly damped heavy rotor systems, resonance occurs when ω is equal to

- (A) $2\omega_{cr}$ (B) $\sqrt{2}\omega_{cr}$ (C) ω_{cr} (D) $\frac{1}{2}\omega_{cr}$

where ω_{cr} is the critical speed.

97. Consider the system of two wagons shown in the given fig. The natural frequencies of this system are



- (A) $0, \sqrt{\frac{2K}{m}}$ (B) $\frac{\sqrt{K}}{m}, \frac{\sqrt{2K}}{m}$ (C) $\frac{\sqrt{K}}{m}, \frac{\sqrt{K}}{2m}$ (D) $0, \frac{\sqrt{K}}{m}$

98. The natural frequency of an undamped vibrating system is 100 rad/sec. A damper with a damping factor of 0.8 is introduced into the system. The frequency of vibration of the damped system, in rad/sec is

- (A) 60 (B) 75 (C) 80 (D) 100

99. The equation of motion for a damped viscous vibration is $3\ddot{x} + 9\dot{x} + 27x = 0$. The damping factor will be

- (A) 0.25 (B) 0.50 (C) 0.75 (D) 1.00

100. A mass of 1 kg is attached to the end of a spring with a stiffness of 0.7 N/mm. The critical damping co-efficient of this system will be

- (A) 1.40 Ns/m (B) 18.522 Ns/m (C) 52.92 Ns/m (D) 529.2 Ns/m