Simulated FE Examination.
2010-1016
Morning Section Simulation

Student Name (Printed) : _____

Instructions

This section of the simulated examination consists of 120 problems, each worth 1 point.

The purpose of the simulation is to diagnose weak subject areas, re-develop familiarity with timed standardized-exams, and develop familiarity with the NCEES supplied reference.

All answers must be supplied on the supplied answer sheet. Both the examination and the answer sheet must be returned — be sure you put your name on both the exam and answer sheet.

The only tools allowed are a pencil, an NCEES approved calculator, and the NCEES supplied reference.

The duration for this section is 4 hours.

You should allocate two 2-hour blocks of time to work the examination. I would suggest the two blocks be on two consecutive days, at the same start and stop time each day. By signing below you are agreeing that you conducted your simulation using only the allowed tools, without consultation of other people.

Block 1
Start Time: _____   Stop Time: _____
Signature: _____

Block 2
Start Time: _____   Stop Time: _____
Signature: _____

Mathematics

1. A growth curve is given by $A = 10e^{2t}$. At what value of t is $A = 100$?

   (A) 5.261

   (B) 3.070

   (C) 1.151

   (D) 0.726.

2. One root of $3x^2 - 2x - 2 = 0$ is

   (A) 1.215

   (B) 1.064

   (C) 0.937

   (D) 0.826

3. $\sqrt{4 + x}$ can be written as the series

   (A) $2 - \frac{x}{4} + \frac{x^2}{64} + \ldots$

   (B) $2 + \frac{x}{8} - \frac{x^2}{128} + \ldots$

   (C) $2 - \frac{x^2}{4} - \frac{x^4}{64} + \ldots$

   (D) $2 + \frac{x}{4} - \frac{x^2}{64} + \ldots$

4. The shortest distance from the line $3x - 4y = 3$ to the point $(6, 8)$ is

   (A) 4.8

   (B) 4.2

   (C) 3.8

   (D) 3.4

5. The equation of a line that has slope -2 and intercepts the x-axis at $x = 2$ is

   (A) $y + 2x = 4$

   (B) $y - 2x = 4$

   (C) $y + 2x = -4$

   (D) $2y + x = 2$

6. Given the vectors:
   $\mathbf{A} = 3\mathbf{i} + 2\mathbf{j} - \mathbf{k}$
   $\mathbf{B} = x\mathbf{i} - 3yz\mathbf{j} + y\mathbf{k}$
   $\mathbf{C} = xy\mathbf{i} - y^2\mathbf{j} - yz\mathbf{k}$

   Find $\mathbf{A} \times \mathbf{B} \bullet \mathbf{C}$ at $\{1, 2, 0\}$.

   (A) $4\mathbf{i} - 7\mathbf{j} - 2\mathbf{k}$

   (B) 28

   (C) $8\mathbf{i} + 28\mathbf{j}$

   (D) 36

7. Given the three matrices: $\mathbf{A} = \begin{bmatrix} 2 & 1 & -2 \\ 0 & 1 & 0 \\ 1 & 2 & 0 \end{bmatrix}$, $\mathbf{B} = \begin{bmatrix} 1 & -2 & 0 \end{bmatrix}$, $\mathbf{C} = \begin{bmatrix} 3 \\ -1 \\ 0 \end{bmatrix}$

Find $\mathbf{B} \bullet \mathbf{C}$.

(A) 0

(B) $\begin{bmatrix} 3 & -6 & 0 \\ -1 & 2 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

(C) $\begin{bmatrix} 3 \\ 2 \\ 0 \end{bmatrix}$

(D) 5

8. Given the three matrices:

$\mathbf{A} = \begin{bmatrix} 2 & 1 & -2 \\ 0 & 1 & 0 \\ 1 & 2 & 0 \end{bmatrix}$, $\mathbf{B} = \begin{bmatrix} 1 & -2 & 0 \end{bmatrix}$, $\mathbf{C} = \begin{bmatrix} 3 \\ -1 \\ 0 \end{bmatrix}$

If $\mathbf{Ax}=\mathbf{C}$, what is the value of x_1?

(A) 0

(B) 1

(C) 2

(D) -1

9. The equation $x^2 - 4xy + y^2 + 4x - 6y + 12 = 0$ represents:

(A) a circle

(B) an ellipse

(C) a parabola

(D) a hyperbola

10. The expression $\frac{cos\theta}{sin\theta} + \frac{sin\theta}{cos\theta}$ can be written as:

(A) $\frac{1}{sin2\theta}$

(B) $\frac{sin2\theta}{2}$

(C) $\frac{2}{cos2\theta}$

(D) $\frac{2}{sin2\theta}$

3

11. Determine y if
$$\begin{array}{rcrcr} x & -y & +z & = & 2 \\ x & & -z & = & 0 \\ x & +y & & = & -3 \end{array}.$$

    (A) $-\frac{2}{3}$

    (B) -8

    (C) $-\frac{4}{3}$

    (D) $-\frac{8}{3}$

12. What is the particular solution to the differential equation $\dot{y} + 4y = 3e^{-t}$.

    (A) $3e^{-t}$

    (B) e^{-4t}

    (C) $c_1 e^{-4t}$

    (D) e^{-t}

13. The vector [cross] product of $\boldsymbol{A} = 4i + 2j$ with $\boldsymbol{B}$ is zero. The inner [dot] product $\boldsymbol{A} \cdot \boldsymbol{B} = 30$. Find $\boldsymbol{B}$?

    (A) $-6i - 3j$

    (B) $6i - 3j$

    (C) $6i + 3j$

    (D) $-6i + 3j$

14. What is the component of $\boldsymbol{A}$ in the direction of $\boldsymbol{B}$ if $\boldsymbol{A} = i - 4j$ and $\boldsymbol{B} = 2i - 4j - 4k$?

    (A) -3

    (B) -2

    (C) 1

    (D) 3

15. A Taylor series representation of $cos2x$ is:

    (A) $2x - \frac{4x^3}{3} + \frac{4x^5}{15} + \cdots$

    (B) $1 + 2x^2 + \frac{2x^4}{3} + \cdots$

    (C) $1 - \frac{x^2}{2} + \frac{x^4}{24} + \cdots$

    (D) $1 - 2x^2 + \frac{2x^4}{3} + \cdots$

16. Find the y-intercept of the line tangent to the parabola $x = 2y^2$ at the point $(2, 1)$.

    (A) -7

    (B) 7

    (C) $\frac{3}{2}$

    (D) $\frac{1}{2}$

17. Express the product $(1 + 2i)(5 + 3i)$ in polar form.

(A) $17.03e^{1.494i}$

(B) $13.04e^{-1.494i}$

(C) $13.04e^{1.648i}$

(D) $17.03e^{-1.494i}$

18. If $f(x) = sin2x$ and $g(x) = x$

What is $\lim\limits_{x \to 0} \frac{f^2}{g^2}$?

(A) 0

(B) 2

(C) 4

(D) -2

Probability and Statistics

19. How many times (approximately) out of 12,000 attempts would a person roll all the same numbers using 5 dice?
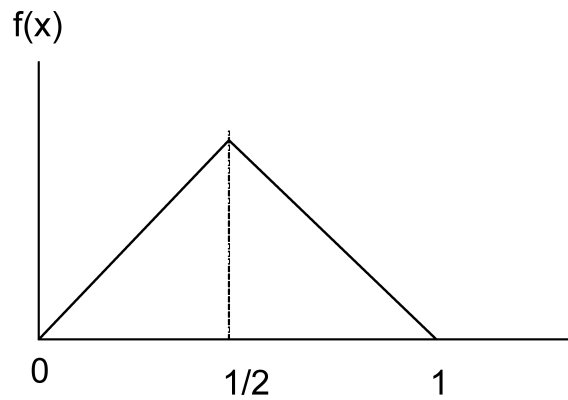
    (A) 50

    (B) 9

    (C) 4

    (D) 2

Figure 1: Probability density function $f(x)$

20. For the probability density function in Figure 1 what is the probability of the random variable x being less than $\frac{1}{3}$?

    (A) 0.11

    (B) 0.22

    (C) 0.25

    (D) 0.33

21. A bag contains 100 balls numbered 1 to 100. One ball is drawn from the bag. What is the probability that the number on the ball selected will be odd, or greater than 80?

    (A) 0.7

    (B) 0.6

    (C) 0.5

    (D) 0.1

22. Samples of monel-alloy tubes were tested for stiffness. The following relative frequency distribution was recorded.

stiffness	proportion
2480	23
2440	35
2400	40
2360	33
2320	21

Assuming a normal distribution, what is the approximate mean of the population from which the samples were obtained?

(A) 2367

(B) 2398

(C) 2402

(D) 2419

23. Five fair coins are flipped once. What is the probability that at least two of the coins will show heads?

(A) 0.19

(B) 0.80

(C) 0.81

(D) 1.50

24. What is the probability of choosing an orange ball from a bag containing seven orange balls, eight green balls, and two white balls?

(A) 1.059

(B) 0.15

(C) 0.24

(D) 0.41

25. What is the sample standard deviation of the data set $\{2.0, 7.0, 9.0, 12, 34\}$?

(A) 11

(B) 12

(C) 13

(D) 17

26. On average a machine jams five times a week. Assuming a Poisson distribution for the jams, the probability the machine jams exactly three times in any given week is

(A) 0.0033

(B) 0.14

(C) 0.33

(D) 1.40

Chemistry

27. Which of the following is the formula for acetic acid?
    (A) $COOH$
    (B) CH_2COOH
    (C) CH_3CH_2COOH
    (D) CH_3COOH.

28. What is oxidized and what is reduced in the following reaction?
    $Zn \ + \ H_2SO_4 \ \rightarrow \ ZnSO_4 \ + \ H_2$
    (A) Zinc is oxidized only.
    (B) Zinc is reduced only.
    (C) ZInc is oxidized, and hydrogen is reduced.
    (D) Zinc is reduced, and hydrogren is oxidized.

29. How many moles of $NaOH$ will be neutralized by 1 mole of H_3PO_4?
    (A) 1/3 moles.
    (B) 1 moles.
    (C) 2 moles.
    (D) 3 moles.

30. How many moles of hydrochloric acid are required to neutralize 1 mole of sodium hydroxide?
    (A) 0.3 moles.
    (B) 0.5 moles.
    (C) 1 moles.
    (D) 1.5 moles.

31. An anode is
    (A) the endpoint of a directed network.
    (B) an electrode at which oxidization occurs.
    (C) an electrode at which reduction occurs.
    (D) the electrode to which a cation would be attracted during an electrolytic reaction.

32. Beryllium, magnesium, and calcium all belong to which elemental grouping?
    (A) noble elements.
    (B) halogens.
    (C) alkali metals.
    (D) alkaline earth metals.

33. What is the mass of 1 atom of carbon-12?

   (A) 5.0×10^{-24} grams

   (B) 2.0×10^{-23} grams

   (C) 4.0×10^{-23} grams

   (D) 7.6×10^{-23} grams

34. Which is the most likely fromula for a compound with the following gravimetric analysis?

oxygen:	13.7%
carbon:	20.5%
hydrogen	5.1%
chlorine	60.7 %

   (A) $CH_3O\ Cl$

   (B) $C_2H_6O\ Cl$

   (C) $C_2H_6O\ Cl_2$

   (D) $CH_6O_2\ Cl.$

35. Balance the following equation.

   $$\text{------} \ PbO_2 \ + \ \text{------} \ H_2SO_4 \ + \ \text{------} \ Pb <=> \text{------} \ H_2O \ + \ \text{------} \ PbSO_4$$

   (A) $3\ PbO_2 \ + \ 6\ H_2SO_4 \ + \ 3\ Pb <=> 6\ H_2O \ + \ 5\ PbSO_4$

   (B) $3\ PbO_2 \ + \ 6\ H_2SO_4 \ + \ 1\ Pb <=> 6\ H_2O \ + \ 4\ PbSO_4$

   (C) $2\ PbO_2 \ + \ 1\ H_2SO_4 \ + \ 2\ Pb <=> 4\ H_2O \ + \ 4\ PbSO_4$

   (D) $1\ PbO_2 \ + \ 2\ H_2SO_4 \ + \ 1\ Pb <=> 2\ H_2O \ + \ 2\ PbSO_4$

36. If one mole of gaseous chlorine combines with 1 mole of calcium to form calcium chloride ($CaCl_2$), which of the following statements is true?

   (A) Calcium has a valence of -1.

   (B) 1 lbm of chlorine will combine with 1 lbm of calcium.

   (C) Chlorine has a valence of -2.

   (D) Chlorine has a valence of +2.

Computers and Control Systems

37. In a spreadsheet, the value in cell A2 is set to 2. The formula in cell B2 is set to =A2*4/A2, where $ is an absolute addressing delimiter. This formula is copied into cells C2 and D2. What is the value in D2?

    (A) 2

    (B) 4

    (C) 8

    (D) 16.

38. A baud is

    (A) a measure of the intervals between transmitted digital data.

    (B) a device to demodulate audio data signals.

    (C) a unit of magnitude of electronically transmitted audio signals.

    (D) a unit of speed in digital data transmission measuring number of signals per second.

39. The following psuedo-code is an example of what kind of programming technique?

        b = cube(a)
        cube(a){
        b=a * a * a
        return(b)
        }

    (A) branching.

    (B) subroutine.

    (C) function call.

    (D) looping.
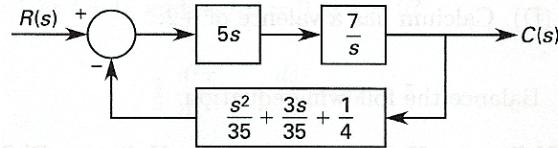
Figure 2: Control system schematic; all values are non-dimensionalized.

40. What is the natural frequency of the control system in Figure 2?

    (A) 0.707

    (B) 3.12

    (C) 5.92

    (D) 9.75

41. Assuming a natural frequency of 5 Hz for the control system in Figure 2 , what is the steady-state gain of the system?

(A) 1.4

(B) 7.0

(C) 16

(D) 180

42. Assuming a natural frequency of 5 Hz for the control system in Figure 2 , what is the damping ratio of the system?

(A) 0.06

(B) 0.3

(C) 0.6

(D) 0.8

43. Assuming a damping ratio of 0.5 for the control system in Figure 2 , what is the damped natural frequency of the system?

(A) 0.866

(B) 3.54

(C) 3.75

(D) 4.33

44. If the control system in Figure 2 , is given a unit step input , how will the response be characterized?

(A) underdamped

(B) overdamped

(C) critically damped

(D) unstable

45. A system has the following transfer function

$$H(s) = \frac{7 + s}{2s^2 + 14s - 36}$$

where s is the frequency in Hz. AT what value of s does the system become unstable?

(A) -7 Hz

(B) 2 Hz

(C) 4 Hz

(D) 9 Hz

Ethics and Business Practices

46. All of the following principles are included in codes of ethics for engineers EXCEPT
    (A) Engineers will place public welfare above personal gain.
    (B) Engineers will serve clients faithfully, honestly, and professionally.
    (C) Engineers will be fair and will act with integrity and courtesy.
    (D) Engineers may use confidential information from companies to obtain business.

47. When resolving ethical conflicts, the guiding principle should be
    (A) The legal framework within which you are working.
    (B) The health, safety, and welfare of the public.
    (C) Your own moral standards and values.
    (D) The codes and standards of your organization.

48. Ethical codes
    (A) Provide specific solutions to ethical problems.
    (B) Serve as an inspiration to behave ethically.
    (C) Are always used in resolving ethical problems.
    (D) Provide broad guidelines for ethical behavior.

49. You are a member of a committee evaluating bids for supply of equipment for a project. Included in the package is a bid from a close personal friend.
    (A) You should reveal this information to the committee and not participate in discussions related to your friend's bid.
    (B) Resign from the committee immediately.
    (C) Evaluate the bids in a fair manner, avoiding any conflict of interest.
    (D) Appoint a substitute to evaluate your friend's bid.

50. Lobbying is a common practice used by vendors. Which of the following represents the least amount of ethical problems?
    (A) You talk to several vendors over the phone and gather information to enable you to make an informed decision.
    (B) You meet with several vendors over lunch and gather information and the vendors pay for the lunches.
    (C) The same as B except you pay for the lunches.
    (D) The same as B except you charge the lunches to the company's expense account.

51. You have discovered a glaring design error that has escaped the attention of your colleague and supervisor. The problem is an an area over which you have no direct responsibility. You should

    (A) Ignore the situation and avoid causing embarrassment to your colleague and supervisor.
    (B) Bring it up during the project meeting scheduled later in the afternoon.
    (C) Bring it to the immediate attention of your colleague using professional tact and courtesy.
    (D) Bring it to the immediate attention of the project manager.

52. A persons behavior is ethical when one:
    (A) Does what is best for oneself.
    (B) Has good intentions, no matter how things turn out.
    (C) Does what is best for everyone.
    (D) Does what is most profitable.

53. Engineers should act ethically because:
    (A) If they dont they risk getting fired.
    (B) The boss wants them to.
    (C) It feels good.
    (D) Thats the way responsible engineers behave.

54. Rules (morals) of professional conduct for engineers require all registered engineers to conform to all but one of the following rules which rule is not required?
    (A) Do not charge excessive fees.
    (B) Do not compete unfairly with others.
    (C) Perform services only in areas of their competence.
    (D) Avoid conflicts of interest.

Economics

55. Profits generated by Excelsys Inc. were $10,000 for the first year and increased by $1,000 each year. If the profits for 5 years of operation were invested at an 8% annual rate of retunr, how much cash had accumulated at the end of the fifth year?

    (A) $47,300

    (B) $55,000

    (C) $60,000

    (D) $69,500

56. Development costs for a new product are estimated to be $70,000 per year for three years. Annual profits from the sale of new product, estimated to be $80,000 will begin in the fourth year and continue for ten years. Using a rate of return of 20% compute the present value of the venture.

    (A) $14,300

    (B) $46,600

    (C) $187,900

    (D) $309,200

57. At the end of each of 12 months Terry deposited $100 in a savings account that pays 6% annual interest compounded monthly. Compute the value in Terry's account immediately after the twelfth payment.

    (A) $1,200

    (B) $1,206

    (C) $1,234

    (D) $1,272

58. How many years are required for an amount of money to triple if invested at a rate of 4%?

    (A) 3

    (B) 7

    (C) 13

    (D) 28

59. Twenty-one equal end-of-year deposits are made into a savings account that pays 4% interest. Compute the amount of each deposit that will permit withdrawals of $10,000 at the ends of the eighteenth through twenty-first years. leaving the account empty.

    (A) $1,328

    (B) $1,667

    (C) $1,905

    (D) $2,123

60. A piece of machinery has in initial cost of $40,000 and results in an increase of annual maintenance costs of $2,000. If the machinery reduces manufacturing costs by $10,000 per year, in how many years will the machine pay for itself if compounding is considered. The effective annual interest rate available to the company is 6%.

    (A) 5.2 years

    (B) 6.1 years

    (C) 7.0 years

    (D) 8.0 years

61. What is the doubling time for a sum of money at a 5% annual compounding rate?

    (A) 6 years

    (B) 10 years

    (C) 11 years

    (D) 14 years

62. A machine has an initial cost of $10,000 and an annual maintenance cost of $450. The service life of the machine is 15 years, and its salvage value is $2500. Assuming an effective annual interest rate of 4%, what is the equivalent uniform annual cost of the machine.

    (A) $1,200

    (B) $1,400

    (C) $1,500

    (D) $1,800

63. The salary range for a particular employee's job has six levels, each one 4% greater than the one below it.. Maintenance of profit algorithms dictate that the employee's salary must be reduced from the top (sixth) level to the second level. This reduction reduces the employee's pay by $140/month. What was the employee's salary per month at level six?

    (A) $ 840

    (B) $ 960

    (C) $ 980

    (D) $3600

Engineering Mechanics – Statics

64. Find the tension in the cable AB
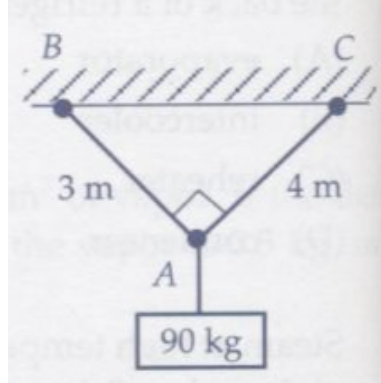
    (A) 706 N

    (B) 530 N

    (C) 264 N

    (D) 72 N

65. The z-component of the force $F = 20i - 30j + 40k$ acting at $(1, 2, 3)$ about the point $(0, 2, 0)$ is

    (A) 89

    (B) 80

    (C) 60

    (D) 30

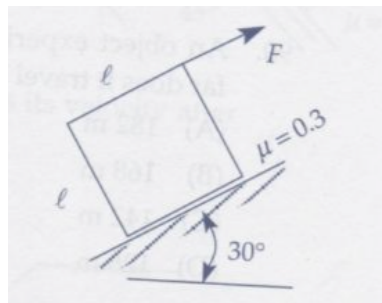66. Find the force in member AB.
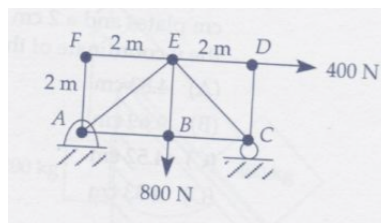
    (A) 0

    (B) 200 N

    (C) 400 N

    (D) 600 N

16

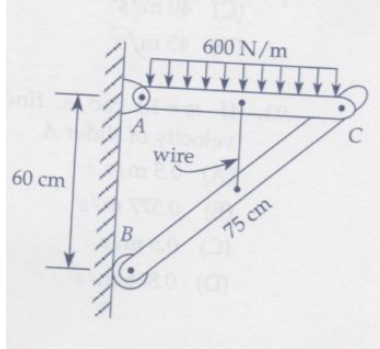67. A force and moment are needed at the wall to hold the rigid link in equilibrium. What is the moment?
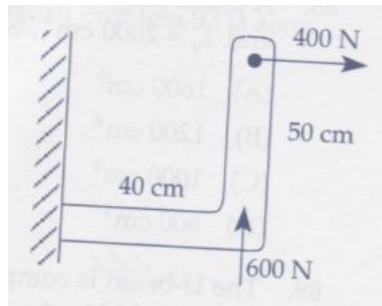
    (A) $20N \bullet m$

    (B) $40N \bullet m$

    (C) $140N \bullet m$

    (D) $240N \bullet m$

68. What force will cause the 20kg block to move?

    (A) 103 N

    (B) 121 N

    (C) 134 N

    (D) 149 N.

69. A wire connects the middle of the two links. What is the tension in the wire?

(A) 540 N
(B) 405 N
(C) 270 N
(D) 195 N

70. The U-beam in is composed of two 2cm by 10 cm plates and a 2cm by 4 cm plate. What is the y-coordinate of the centroid?
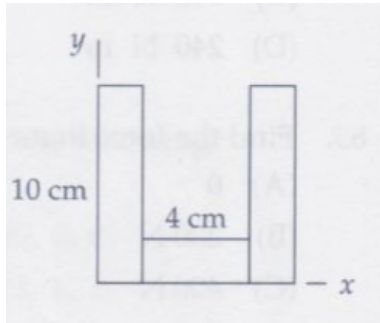
(A) 4.38 cm
(B) 4.69 cm
(C) 4.52 cm
(D) 4.33 cm

Engineering Mechanics – Dynamics

71. If $\omega = 10$ rad/s in Figure 3, find the velocity of slider A.
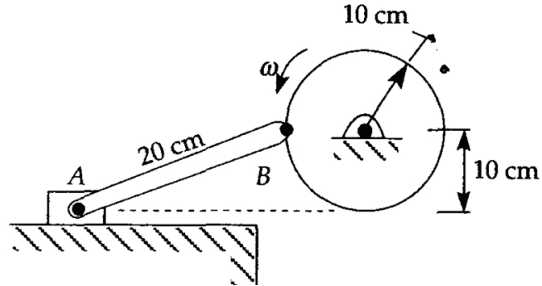
Figure 3: Wheel and Slider

(A) 0.5 m/s
(B) 0.557 m/s
(C) 0.6 m/s
(D) 0.866 m/s

72. If the angular acceleration of the driver wheel Figure 3 is zero, find the acceleration of slider A.

(A) $12.6 m/s^2$
(B) $15.1 m/s^2$
(C) $17.7 m/s^2$
(D) $20.3 m/s^2$

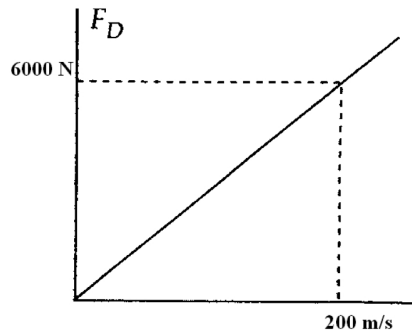73. The two identical balls collide as shown. What is v_2 if the coefficient of restitution is 0.8?
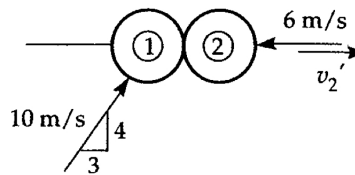
(A) 5.4 m/s
(B) 5.2 m/s
(C) 5.0 m/s
(D) 4.8 m/s

74. Find the tension in the string connecting the two masses. The pulley is massless and frictionless.
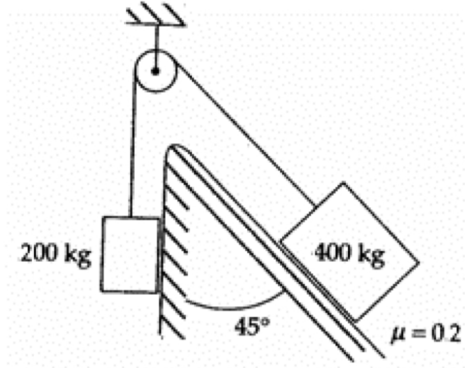

(A) 240 N

(B) 560 N

(C) 1260 N

(D) 2050 N

75. A constant thrust of 20,000 N launches on a 1500-kg rocket vertically upward. If the drag

force F_D is related to the velocity, as shown, find the velocity of the rocket after 20 seconds.

(A) 38 m/s

(B) 42 m/s

(C) 58 m/s

(D) 70 m/s

Engineering Mechanics – Strength of Materials

76. Steel is used to reinforce concrete because
    (A) its density is correctly related to the density of concrete.
    (B) It is relatively inexpensive compared to other metals.
    (C) Its coefficient of thermal expansion is the same as that of concrete.
    (D) Its Poissons ratio is the same as that of concrete

77. Find the maximum tensile stress if the rectangular cross-section is 2 cm x 6 cm (6 cm is vertical).
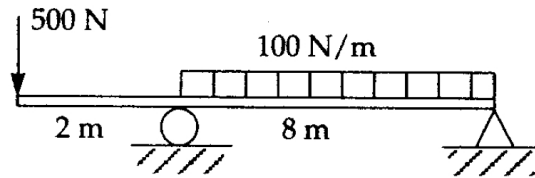
    (A) 92.3 MPa
    (B) 83.3 MPa
    (C) 72.5 MPa
    (D) 64.8 MPa

78. A 4-cm-diameter cantilever steel beam is 6 m long. A uniform load of 100 N/m is applied over 4 m, beginning from the wall. The remaining 2 m is unloaded. What is the deflection of the free end? ($E_{steel} = 210 \times 10^6 kPa.$)
    (A) 20.2 cm
    (B) 16.4 cm
    (C) 14.7 cm
    (D) 12.1 cm

79. A hollow shaft with an inner radius of 2 cm and an outer radius of 3 cm transmits a torque of 300 N-m. What is the maximum shearing stress?
    (A) 17.6 MPa
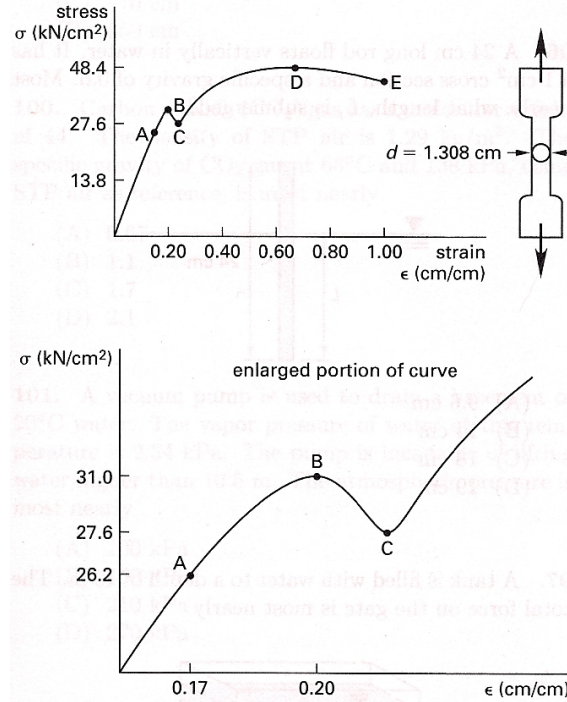   (B) 14.2 MPa
    (C) 12.6 MPa
    (D) 8.81 MPa

Figure 4: Stress-strain curve for cylindrical tension test.

80. The results of a tensile strength test on a cylindrical specimen of a given material are shown in Figure 4. What is the best estimate of yield stress?

(A) 26 kN/cm^2

(B) 28 kN/cm^2

(C) 29 kN/cm^2

(D) 31 kN/cm^2

81. The results of a tensile strength test on a cylindrical specimen of a given material are shown in Figure 4. What is the best estimate of elastic limit stress?

(A) 26 kN/cm^2

(B) 28 kN/cm^2

(C) 31 kN/cm^2

(D) 34 kN/cm^2

22

82. The bending moment diagram of a simply-supported beam with a uniform load over the entire length has the shape of a

(A) rectangle

(B) triangle

(C) parabola

(D) circle

83. A simply-supported beam of length L has a uniform load w of the entire length. What is the ratio of the maximum normal stress to the maximum vertical shearing stress if the cross section is a square $b \times b$?

(A) L/b

(B) $2L/b$

(C) $3L/b$

(D) $4L/b$

84. Calculate the maximum shearing stress at a point where $\tau_{xy} = 10MPa$, $\sigma_x = 40MPa$, and $\sigma_y = 50MPa$.

(A) 46.1 MPa

(B) 36.5 MPa

(C) 23.2 MPa

(D) 11.2 MPa

Material Properties

85. Which type of hardening will work to some extent in all metals?
    (A) work-hardening
    (B) annealing
    (C) martempering
    (D) austenitizing

86. What do impact tests determine?
    (A) hardness
    (B) yield strength
    (C) toughness
    (D) creep strength

87. What is one of the main differences between cast iron and steel?
    (A) Steel has a lower carbon content.
    (B) Steel always contains alloying metals such as nickel, vanadium, chromium, and manganese.
    (C) Steel cannot be annealed, whereas cast iron can.
    (D) Steel contains a large amount of uncombined carbon.

88. For a fixed curing time, the ultimate strength of concrete
    (A) increases with a decrease in water content.
    (B) decreases with an increase in water content.
    (C) is independent of water content of cured for sufficiently long time.
    (D) is independent of curing pressure.

89. An orbital
    (A) may have 2,8,18, or 32 electrons.
    (B) may have 2 electrons with the same spin direction.
    (C) may be photographed with an electron microscope.
    (D) may be unoccupied.

90. The radius of a hypothetical electron orbit is known to be 0.75 Angstroms($A°$). What is the estimated de Broglie wavelength of the electron if four complete cycles constitute a stable pattern around the nucleus?
    (A) 0.19 $A°$
    (B) 1.2 $A°$
    (C) 2.4 $A°$
    (D) 4.7 $A°$

91. For corrosion to occur, which of the following items must be present?
    I .   anode
    II .   cathode
    III . electrolyte

    (A) I and II
    (B) I and III
    (C) II and III
    (D) I, II, and III

92. A system comprised of an open bucket containing a mixture of ice and water is to be warmed from $0 \,°C$ to $20 \,°C$. How many degrees of freedom does the system have?

    (A) 0
    (B) 1
    (C) 2
    (D) 3

Fluid Mechanics and Hydraulics

93. Water flows in a pipe of diameter D with a velocity V. It enters at the center of two parallel disks of radius R separated by a distance t. The water flows radially outward between the disks. The velocity with which the water leaves the disks is

   (A) $\frac{D^2V}{4R^2}$

   (B) $\frac{D^2V}{8Rt}$

   (C) $\frac{DtV}{8R^2}$

   (D) $\frac{DtV}{4R^2}$

94. Bernoullis equation cannot be used to approximate the pressure drop for which of the following?

   (A) across an orifice through which water flows

   (B) across a nozzle through which water flows

   (C) from the free stream to the stagnation point on an airfoil of a small aircraft

   (D) across a Venturi meter

95. The pressure drop over 15 m of 2-cm-diameter galvanized iron pipe is measured to be 60 kPa. If the pipe is horizontal, estimate the flow rate of water. ($\nu = 10 - 6m^2/s$)

   (A) 6.82 L/s

   (B) 2.18 L/s

   (C) 0.682 L/s

   (D) 0.218 L/s

96. The pressure drop across a valve, through which 0.04 m^3/s of water flows, is measured to be 100 kPa. Estimate the loss coefficient if the nominal diameter of the valve is 8 cm.

   (A) 0.32

   (B) 0.79

   (C) 3.2

   (D) 8.7

97. What is the energy requirement of an 85% efficient pump that transports 0.04 m^3/s of water if it increases the pressure from 200 kPa to 1200 kPa?

   (A) 4.8 kW

   (B) 14.2 kW

   (C) 34.0 kW

   (D) 47.1 kW

98. The viscosity of a gas increases with increased temperature because
   (A) internal stickiness of the gas decreases
   (B) internal molecular activity decreases
   (C) internal stickiness of the gas increases
   (D) internal molecular activity increases.

99. Find an expression for the force P needed to hold the gate of width w in the position shown.
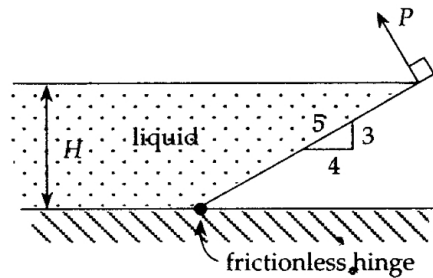
   (A) $5/18\gamma wH^2$
   (B) $1/6\gamma wH^2$
   (C) $2/9\gamma wH^2$
   (D) $1/2\gamma wH^2$

100. Find the difference in pressure between the water and oil if H = 25 cm.
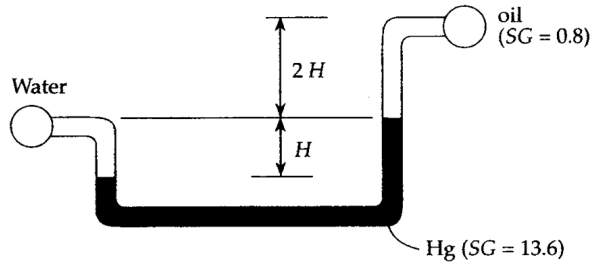
   (A) 42.3 kPa
   (B) 37.2 kPa
   (C) 34.8 kPa
   (D) 30.6 kPa

101. What is the hydraulic radius of an equilateral triangle (vertex down) open channel flowing at depth of 3 meters?

(A) 0.60 m

(B) 0.65 m

(C) 0.70 m

(D) 0.75 m

Electricity and Electronics

102. Six couloumbs of charge pass through a wire in 2 seconds. What is the average current?

    (A) 1.6 A
    (B) 3.0 A
    (C) 4.8 A
    (D) 6.0 A

103. An ideal transformer has 200 primary turns and 20 secondary turns. What is the secondary voltage if the primary voltage is 120V?

    (A) 1.2 V
    (B) 12 V
    (C) 120 V
    (D) 1200 V

104. If 0.3 A flows in the secondary and 30 A flows in the primary of a perfectly matched, ideal transformer, what is the ratio of primary to secondary turns?

    (A) 1:100
    (B) 1:10
    (C) 10:1
    (D) 100:1

105. Five watts are dissipated in a primary (input) circuit that includes a perfectly matched, ideal transformer with a primary-to-secondary turns ratio of 15:1. If the input resistance is 2000 Ω, what is the load resistance?

    (A) 8.9 Ω
    (B) 130 Ω
    (C) 6.2 $k\Omega$
    (D) 30 $k\Omega$

106. What is the total energy dissipated in the resistor when the capacitor discharges?
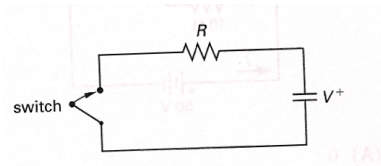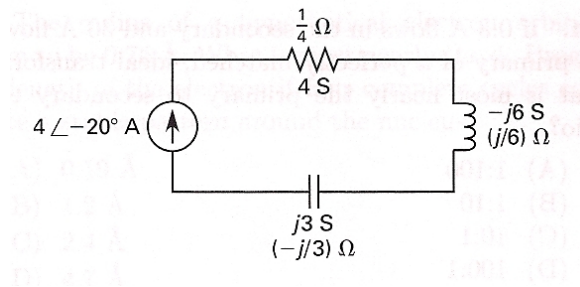

    (A) $V^2 R$
    (B) $\frac{1}{2}CV$
    (C) CV
    (D) $\frac{1}{2}CV^2$

107. What is the phase angle difference between the current and the voltage? Take the voltage as the reference.
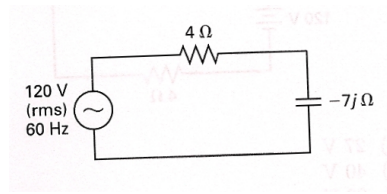
(A) $-60°$

(B) $-35°$

(C) $-30°$

(D) $+30°$

108. What is the phasor voltage drop across the current source?

(A) $0.80 \angle 16.8°$ V

(B) $1.20 \angle -53.7°$ V

(C) $5.00 \angle 36.8°$ V

(D) $6.00 \angle -20.0°$ V

109. A series RLC circuit driven by an AC voltage contains reactances of $X_L = 20\Omega$ and $X_C = 14\Omega$, and $X_R = 10\Omega$. What is the impedance of the circuit at resonance?

(A) 10 Ω

(B) 14 Ω

(C) 20 $k\Omega$

(D) 24 $k\Omega$

110. Two 10 Ω resistors are connected in parallel. The combination is connected in series with a 5 μF capacitor. The circuit is connected across a DC source voltage of 50 V. What is the maximum steady-state current through the battery.
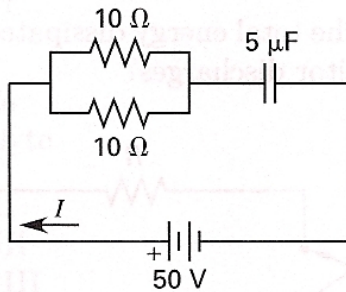
(A) 0 A

(B) 1 A

(C) 5 A

(D) 7 A

111. The voltage across the 4 Ω resistor is
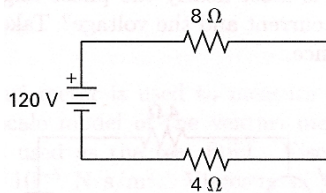
(A) 27 V

(B) 40 V

(C) 80 V

(D) 120 V

Thermodynamics

112. When one system interacts with another system which of the following is possible?

(A) Internal energy can be transferred from one system to the other.

(B) Entropy can be transferred from one system to the other.

(C) One system can induce a force on the other system.

(D) Temperature can be transferred from one system to the other.

113. Select the best response for an isolated system

(A) The entropy of system remains constant.

(B) The heat transfer equals the work done.

(C) The heat transfer equals the internal energy change.

(D) The heat transfer is zero.

114. A tank contains 0.02 m^3 of liquid and 1.98 m^3 of vapor. If the density of the liquid is 960 kg/m^3 and that of the vapor is 0.5 kg/m^3, what is the quality of the mixture?

(A) 5.2%

(B) 4.9%

(C) 2.04%

(D) 1.01%

115. Two kilograms of air are contained in a cylinder. If 80 kJ of heat are added to the air, estimate the temperature rise if the pressure is held constant. $c_p = 1.0$, $c_v = 0.716$kJ/kg-K, $k = 1.4$

(A) 56 $°C$

(B) 40 $°C$

(C) 33 $°C$

(D) 28 $°C$

116. Clothes are hung out to dry in very cold weather. The water in the clothes freezes, but a day later when the clothes are brought inside they are dry. By what process did the drying occur?

(A) vaporization

(B) condensation

(C) evaporation

(D) sublimation

117. The pressure-temperature diagram for water is shown. The names for points A and B and line l are, respectively:
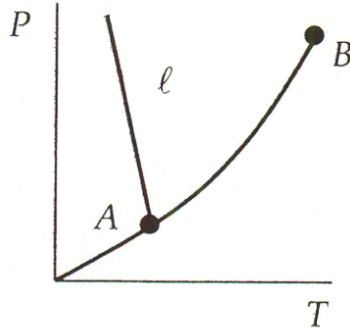
(A) triple, critical, fusion

(B) critical, triple, sublimation

(C) triple, critical, sublimation

(D) critical, triple, fusion

118. Air is compressed in an ideal, adiabatic compressor from 100 kPa and 20 °C to 800 kPa. What is the temperature at the compressor exit? $k = 1.4$.

(A) 1440 °C

(B) 368 °C

(C) 258 °C

(D) 167 °C

119. Vapor refrigerant enters and liquid refrigerant leaves the coils on the back of the refrigerator. These coils are the:

(A) evaporator

(B) intercooler

(C) reheater

(D) condenser

120. A 2.5-cm thick substance has a thermal resistance of $2.0 hr - m - °C/kJ$. Estimate the heat transferred in 15 minutes through a 3 m by 8 m wall if the inside and outside temperatures are -10 °C and 25 °C, respectively.

(A) 6300 kJ

(B) 5400 kJ

(C) 4800 kJ

(D) 4200 kJ