

Simulated FE Examination.  
2010-1014  
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 2 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.  $\sqrt{4+x}$  can be written as the series

- (A)  $2 - \frac{x}{4} + \frac{x^2}{64} + \dots$
- (B)  $2 + \frac{x}{8} - \frac{x^2}{128} + \dots$
- (C)  $2 - \frac{x^2}{4} - \frac{x^4}{64} + \dots$
- (D)  $2 + \frac{x}{4} - \frac{x^2}{64} + \dots$

3. 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  $\mathbf{A} \times \mathbf{B} \cdot \mathbf{C}$  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

4. Given the three matrices:

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

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

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

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

- (A)  $\frac{1}{\sin 2\theta}$
- (B)  $\frac{\sin 2\theta}{2}$
- (C)  $\frac{2}{\cos 2\theta}$
- (D)  $\frac{2}{\sin 2\theta}$

6. Determine  $y$  if  $x$   $-y$   $+z = 2$   
 $x$   $-z = 0$  .  
 $x$   $+y = -3$

- (A)  $-\frac{2}{3}$
- (B)  $-8$
- (C)  $-\frac{4}{3}$
- (D)  $-\frac{8}{3}$

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

- (A)  $3e^{-t}$
- (B)  $e^{-4t}$
- (C)  $c_1e^{-4t}$
- (D)  $e^{-t}$

8. A chain saw makes a 10-inch straight cut in the side of a 24-inch diameter tree. Calculate the angle made by the two radii connecting the ends of the cut. The cut is perpendicular to the tree's axis.

- (A)  $131^\circ$
- (B)  $49.2^\circ$
- (C)  $45.2^\circ$
- (D)  $24.6^\circ$

9. 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)  $\frac{1}{2}$

# Probability and Statistics

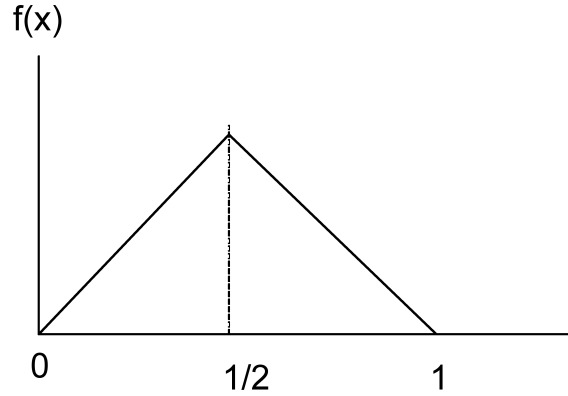


Figure 1: Probability density function  $f(x)$

10. 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
11. 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

12. 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
13. 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

## Chemistry

14. Which of the following is the formula for acetic acid?
- (A)  $COOH$
  - (B)  $CH_2COOH$
  - (C)  $CH_3CH_2COOH$
  - (D)  $CH_3COOH$ .
15. 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 hydrogen is oxidized.
16. 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.
17. An anode is
- (A) the endpoint of a directed network.
  - (B) an electrode at which oxidation occurs.
  - (C) an electrode at which reduction occurs.
  - (D) the electrode to which a cation would be attracted during an electrolytic reaction.

18. Which is the most likely formula for a compound with the following gravimetric analysis?

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

- (A)  $CH_3OCl$
- (B)  $C_2H_6OCl$
- (C)  $C_2H_6OCl_2$
- (D)  $CH_6O_2Cl$ .

## Computers and Control Systems

19. In a spreadsheet, the value in cell A2 is set to 2. The formula in cell B2 is set to  $=A2*4/ \$A\$2$ , 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.

20. 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.

21. The following pseudo-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.

22. 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

## Engineering Ethics and Business Principles

23. 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.
24. 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.
25. You have discovered a glaring design error that has escaped the attention of your colleague and supervisor. The problem is in 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.
26. 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.

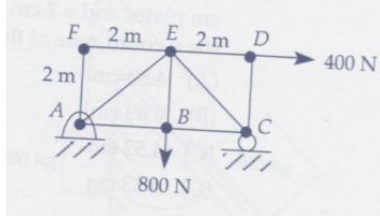
## Economics

27. 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
28. 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
29. 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
30. 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



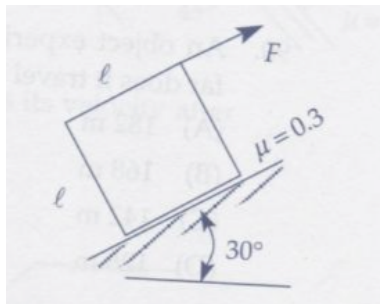
## Engineering Mechanics – Statics

31. Find the force in member  $AB$ .



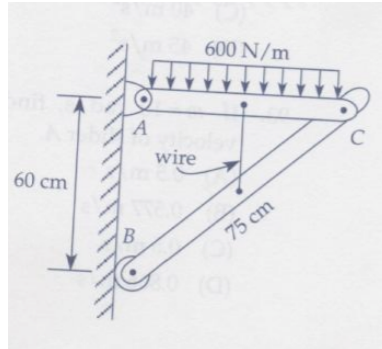
- (A) 0
- (B) 200 N
- (C) 400 N
- (D) 600 N

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

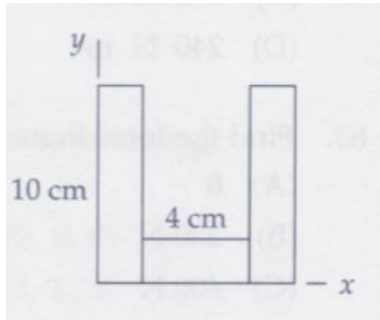


- (A) 103 N
- (B) 121 N
- (C) 134 N
- (D) 149 N.

33. 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
34. 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

35. If  $\omega = 10 \text{ rad/s}$  in Figure 2, find the velocity of slider A.

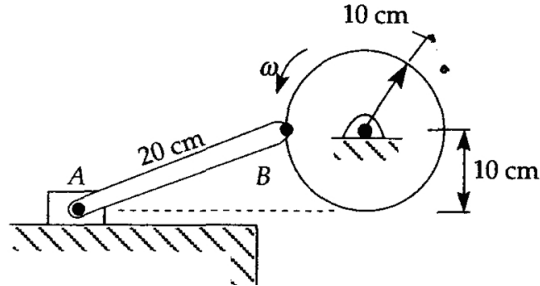
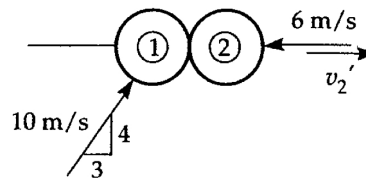


Figure 2: Wheel and Slider

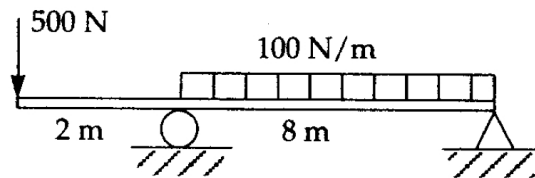
- (A) 0.5 m/s  
 (B) 0.557 m/s  
 (C) 0.6 m/s  
 (D) 0.866 m/s
36. If the angular acceleration of the driver wheel Figure 2 is zero, find the acceleration of slider A.
- (A)  $12.6 \text{ m/s}^2$   
 (B)  $15.1 \text{ m/s}^2$   
 (C)  $17.7 \text{ m/s}^2$   
 (D)  $20.3 \text{ m/s}^2$
37. The two identical 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

## Mechanics of Materials

38. 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
39. 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
40. 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

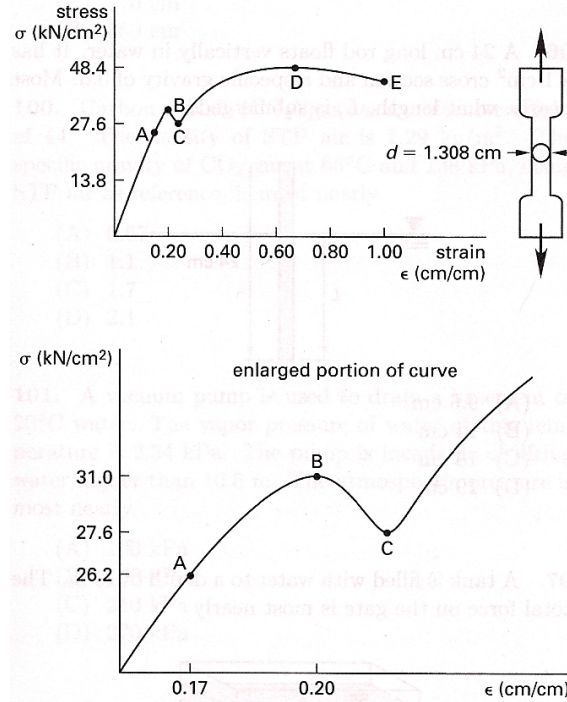


Figure 3: Stress-strain curve for cylindrical tension test.

41. The results of a tensile strength test on a cylindrical specimen of a given material are shown in Figure 3. What is the best estimate of yield stress?
- (A)  $26 \text{ kN/cm}^2$   
 (B)  $28 \text{ kN/cm}^2$   
 (C)  $29 \text{ kN/cm}^2$   
 (D)  $31 \text{ kN/cm}^2$
42. 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)  $4L/b$

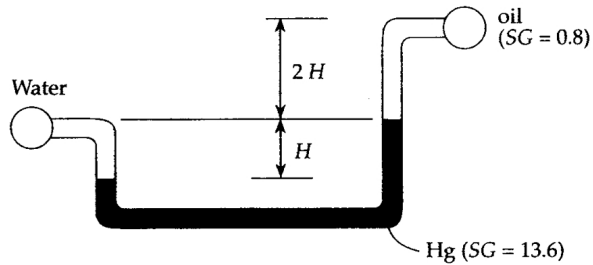
## Materials Science

43. What do impact tests determine?
- (A) hardness
  - (B) yield strength
  - (C) toughness
  - (D) creep strength
44. 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.
45. The radius of a hypothetical electron orbit is known to be 0.75 Angstroms(  $A^\circ$ ). What is the estimated de Broglie wavelength of the electron if four complete cycles constitute a stable pattern around the nucleus?
- (A) 0.19  $A^\circ$
  - (B) 1.2  $A^\circ$
  - (C) 2.4  $A^\circ$
  - (D) 4.7  $A^\circ$
46. 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

## Engineering Mechanics – Fluids

47. 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)  $\frac{DtV}{4R^2}$

48. The pressure drop across a valve, through which  $0.04 \text{ m}^3/\text{s}$  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
49. What is the energy requirement of an 85% efficient pump that transports  $0.04 \text{ m}^3/\text{s}$  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
50. Find the difference in pressure between the water and oil if  $H = 25 \text{ cm}$ .

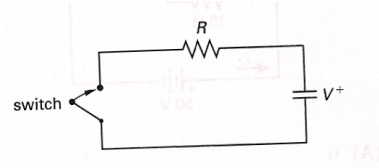


- (A) 42.3 kPa  
 (B) 37.2 kPa  
 (C) 34.8 kPa  
 (D) 30.6 kPa

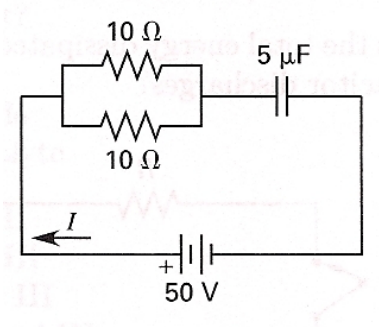
## Electricity and Electronics

51. Six coulombs 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

52. 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
53. What is the total energy dissipated in the resistor when the capacitor discharges?



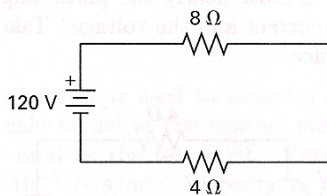
- (A)  $V^2R$   
 (B)  $\frac{1}{2}CV$   
 (C)  $CV$   
 (D)  $\frac{1}{2}CV^2$
54. Two  $10\ \Omega$  resistors are connected in parallel. The combination is connected in series with a  $5\ \mu F$  capacitor. The circuit is connected across a DC source voltage of 50 V. What is the maximum steady-state current through the battery.



- (A) 0 A  
 (B) 1 A  
 (C) 5 A  
 (D) 7 A



55. The voltage across the  $4\ \Omega$  resistor is

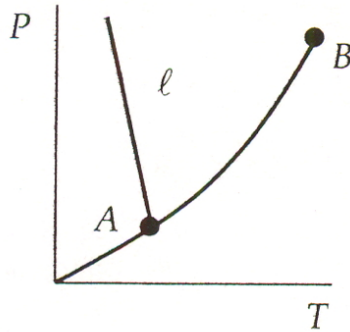


- (A) 27 V
- (B) 40 V
- (C) 80 V
- (D) 120 V

## Thermodynamics

56. 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.
57. 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.
58. 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

59. 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
60. 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