Sree Chitra Tirunal Institute for Medical Science and Technology, Trivandrum

Engineering Staff Selection

Screening Test

1st June, 2018

Instructions

1. There are 50 questions.
2. Each question has only one correct answer.
3. Mark your answer in the answer sheet provided.
4. Use the sheets provided for rough work.
5. You may not use calculators or any other electronic device.

1. A certain voltmeter has internal resistance of 10 kΩ and full-scale range of 10V. If a resistance of 100 kΩ is connected in series, the range becomes:
   (a) 10 V
   (b) 110 V
   (c) 150 V
   (d) 100 V
   (e) 90 V

2. A DC motor with a coil resistance of 10 Ω has 6 V across it. If the current through the motor is 250mA, what is the back e.m.f ?
   (a) 1.5 V
   (b) 2.5 V
   (c) 3.5 V
   (d) 4.5 V
   (e) 5.5 V

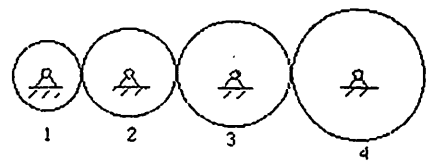
3. An ammeter of range 100 mA and internal resistance of 10 Ω has a 1 Ω resistor connected in parallel across it. What is its new range?
   (a) 1.1 A
   (b) 1.5 A
   (c) 10 A
   (d) 0.9 A
   (e) 1.0 A

4. What will be the printed value of "x" in this program segment?
   (a) 25
   (b) 32
   (c) 50
   (d) 64
   (e) 100

```
int x, a;
a=2;
x=1;
while (x <= 25) {
   a = a*a;
   x = x*a;
}
printf("x=%d", x);
```

5. A sinusoidal voltage source of amplitude 100V is applied across an impedance, 3+j4. (Note: $j=\sqrt{-1}$) What is the magnitude of the current?
   (a) 1 A
   (b) 14 A
   (c) 20 A
   (d) 28 A
   (e) 50 A

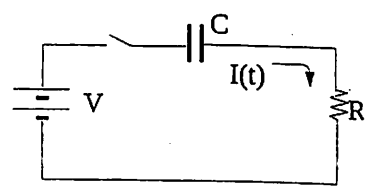
6. Four gears are connected as shown in the figure. The teeth are in the ratio, **1 : 1½ : 2 : 3.** The first gear is rotated clockwise at a speed of 30 RPM (revolutions per minute). What is the speed and direction (clockwise, CW, or counterclockwise, CCW) of the fourth gear?
   (a) 3 RPM, CW
   (b) 3.33 RPM, CCW
   (c) 4.5 RPM, CW
   (d) 10 RPM, CCW
   (e) 30 RPM, CW



7. A 50 Hz sinusoidal voltage source of amplitude 10V is applied to a motor with impedance comprising a 3Ω resistance and 12.7mH inductance. What is the magnitude of the current?
   (a) 1 A
   (b) 2.5 A
   (c) 2 A
   (d) 7 A
   (e) 3.33 A

8. A 10 megapixel digital camera is used to take a photograph of an A4 sheet of paper (A4=216mmx280mm). What is the resolution of the image in mm^2/pixel?
   (a) 165
   (b) 0.006
   (c) 0.01
   (d) 120
   (e) 28

9. In the circuit shown here, what is the current, $I(t)$, if the switch is closed at time t=0 ?
   (a) V_s / R
   (b) 1 Amp
   (c) $e^{-t/RC}$
   (d) $[1-e^{t/RC}]$
   (e) log(t/RC)



10. The Laplace transform of e^{-10t} *for* $t \geq 0$ is:
   (a) 10s
   (b) 1/(s+10)
   (c) 10+s
   (d) 10/(10+s)
   (e) 10-s

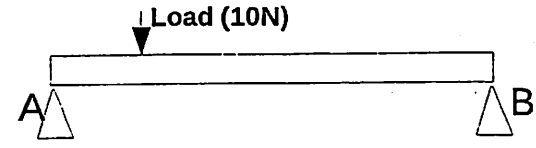
11. The binary representation of the decimal number 13.625 is:
   (a) 1101.1000
   (b) 1101.1110
   (c) 1101.1010
   (d) 1011.1100
   (e) 1011.0011

12. A bicycle wheel of diameter 75cm has a sprocket with 15 teeth. This is driven by a chain wheel with 60 teeth and the crank length is 25cm. When the crank (pedal) is horizontal, and a force of 200N is applied, what is the horizontal force on the ground?
   (a) 25N
   (b) 33.33 N
   (c) 50.0 N
   (d) 66.67 N
   (e) 100 N

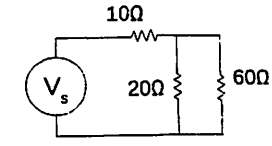
13. An LED and a resistor are connected in series to a 3V battery. The junction voltage of the LED is 1.27V and the value of the resistor is 100Ω. What is the power dissipated in the resistor?
    (a) 1 W
    (b) 3 W
    (c) 30 mW
    (d) 100 mW
    (e) 173 mW

14. The relation between displacement and force in a spring is similar to the relation between which of the following:
    (a) Charge and voltage in a capacitor
    (b) current and voltage in a capacitor
    (c) charge and voltage in a resistor
    (d) power and voltage in a resistor
    (e) force and velocity in a spring

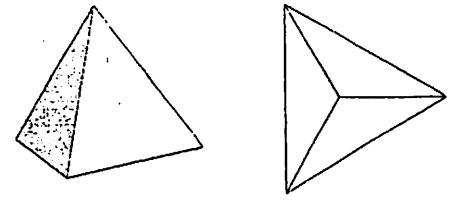
15. A 1m long bar is supported at both ends as shown, and a 10N load is placed 20cm from one end. What is the reaction force at support A?
    (a) 2N
    (b) 5N
    (c) 8N
    (d) 10N
    (e) 12N



16. In the following circuit, if the voltage V_s=10V, the current through the 20Ω resistor has value:
    (a) 0.01A
    (b) 0.05A
    (c) 0.10A
    (d) 0.30A
    (e) 0.70A



17. This figure shows the isometric view and plan of a symmetrical pyramid of side l. What is its height?
    (a) $\left(\sqrt{\frac{2}{3}}\right)l$
    (b) $\frac{l}{\sqrt{3}}$
    (c) $\frac{l}{\sqrt{5}}$
    (d) $\frac{l}{2}$
    (e) $\frac{l}{3}$



18. An LED is connected to a 3V battery through a 100Ω resistor. The junction voltage of the LED is 1.2 V. What is the ratio of the power used by the LED to the power lost in the resistor?
    (a) 0.667
    (b) 1
    (c) 1.5
    (d) 2
    (e) 3

19. A cycle wheel gets a thorn stuck on the tyre. If the cyclist continues to ride, what is the trajectory of the thorn?

(a) 

(b) 

(c) 

(d) 

(e) None of these

20. A car headlight incandescent bulb is rated 12V, 36W. If it is connected to 8 penlight cells (1.5V each) in series. Each penlight cell has an internal resistance of 4 Ω. How much power will the bulb *approximately* consume?
    (a) 40W
    (b) 10W
    (c) 0.5W
    (d) 8W
    (e) 36W

21. The outline of the isometric view of a cube will be:
    (a) Octogon
    (b) Hexagon
    (c) Square
    (d) Rectangle
    (e) Line

22. A feedback control system has a forward path transfer function, $G(s)$ and feedback path transfer function, $H(s)$. This feedback system will be unstable if:
    (a) G(s)H(s)=1
    (b) 1+G(s)H(s)=0
    (c) G(s)/H(s)=1
    (d) G(s)=H(s)
    (e) G(s)=1-H(s)

23. The inverse Laplace transform of $\frac{1}{(s+2)(s+10)}$ for $t \geq 0$:
    (a) $\frac{1}{8}[e^{-2t}-e^{-10t}]$
    (b) $[e^{-12t}]$
    (c) $[e^{-8t}]$
    (d) $12[e^{-8t}]$
    (e) $3t$

24. A sinusoidal current source of frequency 159 Hz and amplitude 10A is connected to a parallel combination of a 10μF capacitor and 100 Ω resistor. What is the phase angle of the voltage?
    (a) -90°
    (b) 0°
    (c) -45°
    (d) +90°
    (e) 180°

25. When you lift a 5 kg weight with the palm of your hand, what is the approximate force produced by the biceps muscle? The length of the forearm is about 30cm and the insertion of the biceps is about 3cm from the elbow joint.
    (a) 50 N
    (b) 500 N
    (c) 5 N
    (d) 10 N
    (e) 100 N

26. An oscilloscope with internal resistance of 1 MΩ is used to measure the voltage from a sensor with internal source resistance of 100 kΩ. If the voltage measured on the oscilloscope is 10mV, what is the true voltage from the sensor?
    (a) 11 mV
    (b) 20 mV
    (c) 12 mV
    (d) 7 mV
    (e) 15 mV

27. An instrumentation amplifier has CMRR of 60dB. It is used to measure a signal of differential amplitude 25mV. Mains supply electromagnetic interference is 250mV at the input of the amplifier. What is the signal-to-noise ratio (SNR) at the output?
    (a) 10 dB
    (b)
    (c)
    (d) 40 dB
    (e)

28. A battery has an open-circuit voltage of 4.0V and a short-circuit current of 2A. If it is short-circuited, what will be the internal power dissipation?
    (a) 10 W
    (b) 9 W
    (c) 8 W
    (d) 4 W
    (e) 2 W

29. A microcontroller with clock of 40MHz and instruction of 4 clock cycles is used to sample data and digitally filter it. The digital filter uses 60 instructions for each output calculation – additionally 5 instructions are used to acquire each sampled point. Which is the fastest sampling rate that can be used?
    (a) 500 kHz
    (b) 300 kHz
    (c) 250 kHz
    (d) 150 kHz
    (e) 100 kHz

30. If two incandescent bulbs rated 240V/60W each are connected in series to a 240V mains supply, what will be the power consumed?
    (a) 30W
    (b) 60 W
    (c) 120 W
    (d) 90 W
    (e) 150 W

31. A capacitor of value 10μF is connected in parallel with an inductor of value 1mH. If an initial charge is applied to the capacitor, what will be the frequency of oscillation? Neglect resistive losses.
    (a) 10 kHz
    (b) 1.6 kHz
    (c) 64 kHz
    (d) 80 kHz
    (e) 120 kHz

32. A transformer with turns ratio 50:1 is connected to the mains supply of 250V. If the load on the secondary side consumes 5W, what is the current drawn on the primary, mains side?
    (a) 2 mA
    (b) 10 mA
    (c) 20 mA
    (d) 40 mA
    (e) 80 mA

33. An input voltage signal is connected across a resistor and capacitor in series. If an output voltage is measured across the capacitor, it will be a:
    (a) high-pass filter
    (b) low-pass filter
    (c) all-pass filter
    (d) differentiator
    (e) non-linear attenuator

34. Cell membranes made of lipid-bilayer have electrical permittivity of 50×10^{-12} F/m. If the thickness of such a cell membrane is 10nm, what is the capacitance of a $1cm^2$ patch of cell membrane?
    (a) 0.1 F
    (b) 0.5 μF
    (c) 25 F
    (d) 50 μF
    (e) 125 μF

35. Which of the following is a point of intersection between the parabola, $y=2x^2+3x-5$ and the straight line, $y=6x-3$?
    (a) (0,-3)
    (b) (0,-5)
    (c) (-3,-5)
    (d) (2,9)
    (e) (1,3)

36. An elastic ball of mass 1 kg is dropped from a height of 2m, and bounces up to a height of 1.5m. What is the energy lost as heat and sound?
    (a) 2 J
    (b) 1 J
    (c) 0.5 J
    (d) 0.25 J
    (e) 0.2 J

37. Insulated laminated sheets of iron are used to make transformer cores instead of solid iron because:
(a) lighter weight
(b) less hysteresis
(c) eddy currents are reduced
(d) light weight and more eddy current
(e) short-circuit protection

38. The size of an uncompressed image file of size 1000 x 1000 pixels and 16 colours, is:
(a) 40 MB
(b) 1.6 MB
(c) 16 MB
(d) 4 MB
(e) 32 MB

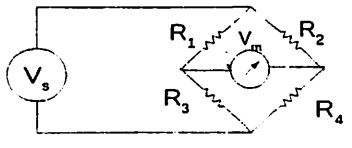
39. The electroencephalogram has a maximum amplitude 50μV. During its recording there is noise picked up of amplitude 0.05μV. What is the appropriate number of bits for its quantization?
(a) 8 bits
(b) 10 bits
(c) 12 bits
(d) 16 bits
(e) 18 bits

40. The electroencephalogram is bandlimited in the range DC-35Hz. The minimum sampling rate is:
(a) 35 Hz
(b) 50 Hz
(c) 70 Hz
(d) 100 Hz
(e) 350 Hz

41. High voltages are used for long-distance transmission of electrical power because:
(a) it causes less power loss in transmission
(b) it will prevent electricity theft
(c) electricity generator produce high voltages
(d) causes less interference with mobile phones
(e) high current is desired

42. A wire of cross-sectional diameter $1mm^2$ and length 1m is stretched to 1.2m. If the volume of the wire is unchanged, what is the percentage change in resistance of the wire?
(a) -2%
(b) +44%
(c) +20%
(d) -20%
(e) +2%

43. The Wheastone bridge in the figure has resistor values R_1=1kΩ, R_2=1kΩ, R_3=1kΩ, R_4=4kΩ. If the excitation is V_s=10V, what is the magnitude of the measured output voltage V_m ?
(a) 0V
(b) 1V
(c) 3V
(d) 5V
(e) 2.5V



44. Switching power supplies are preferred over linear power supplies because:
    (a) they are less noisy
    (b) they require fewer components
    (c) they are more efficient
    (d) they require less semiconductors
    (e) they only require passive components

45. If an analog-to-digital converter has an input range of 0 to 4V, and a minimum resolution of 1 mV is desired, how many bits of conversion should it have?
    (a) 8 bits
    (b) 10 bits
    (c) 12 bits
    (d) 16 bits
    (e) 20 bits

46. A system with the transfer function: $[s^3+2s^2+3s+6]^{-1}$ has one pole at $s=-2$. The system is:
    (a) stable
    (b) unstable
    (c) marginally stable
    (d) indeterminate
    (e) stable for sinusoidal input

47. If an instrumentation amplifier has a CMRR=60dB, and the common mode gain is 1, then its difference mode gain is:
    (a) 60
    (b) 100
    (c) 600
    (d) 1000
    (e) 6000

48. A mass of 10 kg and density 5000kg/m^3 is suspended **under water** from a spring of spring constant 1000 N/m. What will be the approximate extension of the spring?
    (a) 1 cm
    (b) 8 cm
    (c) 0.8 cm
    (d) 1.2 cm
    (e) 12 cm

49. The time derivative of a sinusiod, $\sin(2\pi f t)$, has the following property:
    (a) the amplitude is unchanged
    (b) amplitude changes proportional to frequency
    (c) the frequency doubles
    (d) the frequency halves
    (e) the frequency becomes zero

50. The composition of lead-free solder is:
    (a) tin+manganese
    (b) tin+silver+copper
    (c) silver+gold+platinum
    (d) tin+aluminium
    (e) silver+aluminium