BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
First Semester 2017-2018
Electronic Instruments and Instrumentation Technology (INSTR F311)

MM = 50 Time 90 Mins Final semester Closed book Date 07.12.2017

ID: Name:

1. Determine the signal frequency f_s at which a coaxial probe with 26 pF capacitance will produce a 3 dB reduction in the signal from a 300 Ω source.

   (a) 30.4 MHz (b) 28.4 MHz

   (c) 35.4 MHz (d) 20.4 MHz

2. A Lissagious pattern can be used to measure

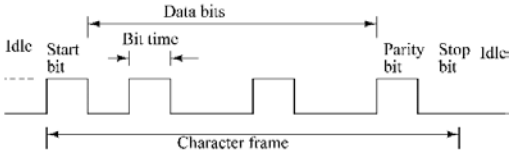
   (a) Frequency but not phase

   (b) Phase but not frequency

   (c) Both frequency and phase

   (d) None

3. For 9600 baudrate, calculate the time taken to transmit following character frame in binary system.



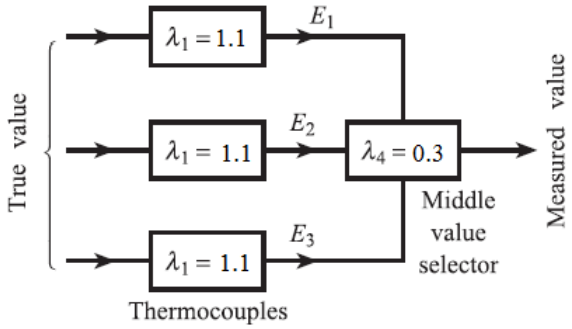
   (a) 1.040 ms (b) 10.04 ms
   (c) 1.040 μs (d) 10.04 μs

4. Dynamic range for a 8-bit ADC is

   (a) 38.16 dB (b) 58.16 dB

   (c) 84.16 dB (d) 48.16 dB

5. A measurement system consists of following blocks. λ represents failure rate. If the usage of the instrument is for 0.5 year, calculate the reliability of the system.



   (a) 0.595 (b) 0.795

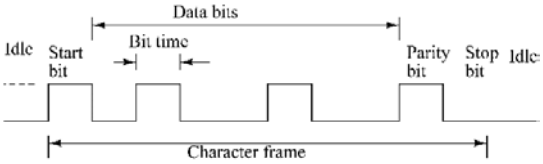
   (c) 0.695 (d) 0.885

6. The time base in an electronic counter is 2 μs. If the count is 3657, the period of the unknown signal will be

   (a) 7.314 ms (b) 6.314 ms

   (c) 1828.5 ms (d) 73.14 ms

7. Calculate the efficiency of the protocol to transmit the following character frame.



   (a) 70% (b) 80%

   (c) 90% (d) 60%

8. If a force sensor of 0-10 N range is calibrated using HART protocol, then 2.5 N force represents how much current

   (a) 12 mA (b) 4 mA

   (c) 8 mA (d) 16 mA

9. A 3¾-digit digital multimeter on the 0 V – 4 V scale can measure up to

   (a) 3.444 V (b) 3.334 V

   (c) 3.344 V (d) 3.999 V

10. The chart speed of a recording instrument is 30 mm/s. One cycle of the signal being recorded extends over 5 mm (time base). Calculate the frequency of the signal

    (a) 6 cycles/sec (b) 5 cycles/sec

    (c) 7 cycles/sec (d) 8 cycles/sec

11. If the baudrate is 4800 and there are two bits per symbol. The bit rate is

    (a) 4800 (b) 9600 (c) 2400 (d) 12000

12. A moving coil instrument with coil-turn 100 and cross sectional area 600 mm^2 experiences a torque 30×10^{-6} Nm in magnetic flux density 0.1 Wb/m^2. Calculate the current flowing through the coil.

    (a) 7 mA (b) 5 mA

    (c) 10 mA (d) 8 mA

13. In binary system

    (a) Bit rate = Baudrate

    (b) Bit rate > Baudrate

    (c) Bit rate < Baudrate

    (d) Bit rate = 2× Baudrate

14. Calculate the reliability of a frequency measurement instrument having constant failure rate $\lambda=0.02$ yr^{-1} and usage for 5 yrs.

    (a) 0.9 (b) 0.5

    (c) 0.4 (d) 0.7

15. A 4½ digit digital multimeter display has maximum capability to read

    (a) 19999 (b)1999

    (c) 4999 (d) 49999

16. The full form of HART communication protocol is

    (a) Highbus Addressable Remote Transducer

    (b) Highway Addressable Remote Transmission

    (c) Highway Addressable Remote Transducer

    (d) Highbus Addressable Remote Transmission

17. Organize the following oscillators in descending order in terms of their ability to produce high frequency

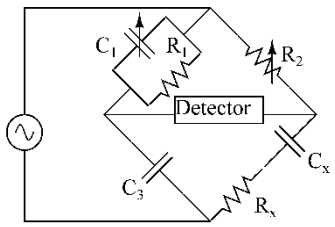
    (a) RC Phase shift < Hartley < Crystal

    (b) Hartley < RC Phase shift < Crystal

    (c) RC Phase shift < Crystal < Hartley

    (d) Crystal < RC Phase shift < Hartley

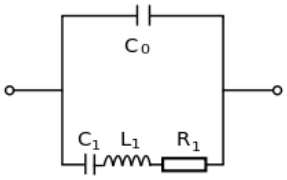
18. C_1=0.5 μF, R_1=1 kΩ, R_2=2 kΩ, C_3=0.5 μF and operating frequency is 1 kHz. Calculate R_x and C_x in the following circuit



    (a) 2 kΩ, 0.25 μF (b) 4 kΩ, 0.35 μF

    (c) 1 kΩ, 0.15 μF (d) 3 kΩ, 0.45 μF

19. A piezoelectric crystal has C_0=20 pF, L_1=1 H, C_1 = 0.01 pF, R_1=1 kΩ. Calculate the series and parallel resonant frequency



(a) f_s=1489 kHz, f_p=1490 kHz

(b) f_s=1389 kHz, f_p=1390 kHz

(c) f_s=1689 kHz, f_p=1690 kHz

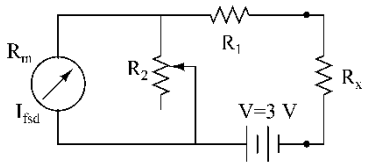
(d) f_s=1589 kHz, f_p=1590 kHz

20. A power level of 0 dBm corresponds to

(a) 1 mW (b) 0 mW

(c) 10 mW (d) 0.1 mW

21. A series type ohm-meter is shown below. R_m=100 Ω, I_{fsd}= 1mA, and half scale deflection marking range 1 kΩ is required. Calculate R_1 and R_2



(a) R_1 = 866.7 Ω, R_2=90 Ω

(b) R_1 = 966.7 Ω, R_2=50 Ω

(c) R_1 = 766.7 Ω, R_2 = 80 Ω

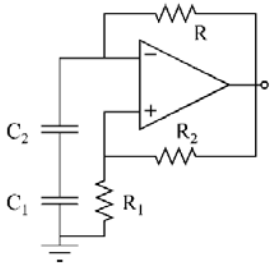
(d) R_1 = 666.7 Ω, R_2 = 70 Ω

22. A low pass RC filter acts as pure integrator when

(a) ωτ = 1 (b) ωτ << 1

(c) ωτ >> 1 (d) ωτ = 0

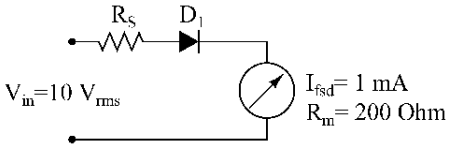
23. Determine the type of output wave form and the period of oscillation of the following circuit for R=R_1=R_2 = 1 kΩ, C_1=C_2=2 μF.



(a) Triangular,2.2 ms (b) Square,2.2 ms

(c) Square,3.2 ms (d) Triangular,3.2 ms

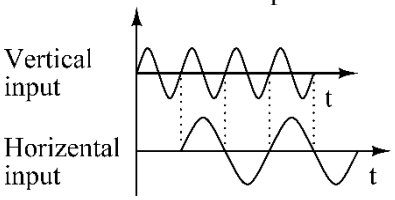
24. Calculate the sensitivity of the PMMC device and find the multiplier resistor R_s of the following



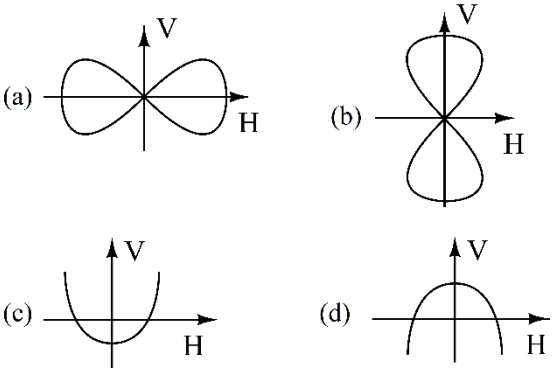
(a) 2 kΩ, 3.2 kΩ (b) 1 kΩ, 4.3 kΩ

(c) 1.5 kΩ, 7.2 kΩ (d) 3.1 kΩ, 3 kΩ

25. Two following signals are applied to the vertical and horizontal plates of a CRT.



Which Lissajous curve will you get from this configuration?



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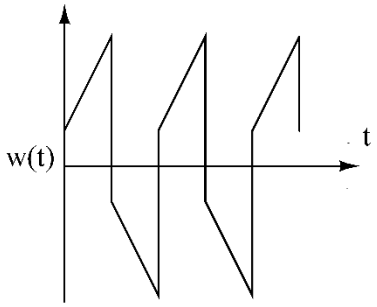
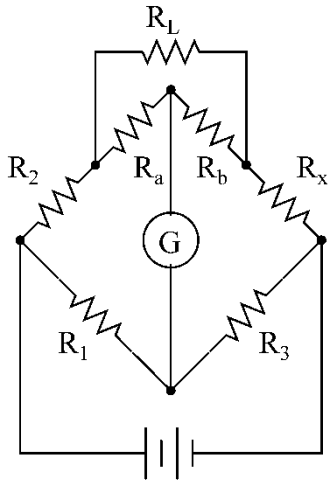
1. Design a circuit network which will generate following voltage signal. [10]



2. ASCII code of 'G' is 01000111. How will you send this character 'G' using RS232 protocol show the wave form. [5]

3. A modified form of a Wheatstone bridge is shown in Fig. Calculate the value of unknown resistance, R_x, if $R_a = 1.2$ kΩ, $R_a = 1600\ R_b$, $R_1 = 800\ R_b$, $R_1 = 1.25\ R_2$ and $R_3 = 0.5\ R_b$ are the resistance values under balanced condition. [15]



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4. The output of an opamp-based basic differentiator with parameters R = 150 Ω and C = 100 pF is followed by a unity gain buffer, and is connected to an oscilloscope using a coaxial cable for measurement. The opamp has a gain of 100 dB and 3dB bandwidth of 1 MHz. The coaxial cable is of 10 cm length and has resistance 20 Ω/cm and capacitance 0.5 pF/cm. The oscilloscope has an input capacitance of 100 pF. (a) Plot the frequency response of the overall system considering an input voltage v_i to the input of the differentiator and v_o to the input of the oscilloscope. (b) Calculate the frequency at which the input voltage signal will be reduced by 3dB. (c) Comment on the feasibility of this system. [4+4+2=10]

5. (a) An electron beam in a CRT is accelerated through a potential difference of 1000 V. The beam then travels through a pair of deflection plates of axial length 2 cm, the separation between the plates being 5 mm. The Potential difference applied between the deflecting plates is 20 V. The distance of the CRT screen from the center of the deflecting plates is 25 cm, mass of the electron is 9.11×10^{-31} kg and charge of the electron is 1.6×10^{-19} C. Determine
   (i) The transit time of the beam through the deflecting plates
   (ii) Transverse acceleration imparted to the electrons by the deflecting voltage
   (iii) Deflection of the spot on the CRT screen and
   (iv) Calculate the deflection sensitivity.

   (b) Two voltages: $v_x = A \sin \omega t$ and $v_y = A \sin (\omega t + \alpha)$ are fed to the horizontal and vertical plates, respectively. Mathematically show and draw the Lissajous figure you will get with these two signals for $0 < \alpha < 90^o$. [2+2+3+3+5=15]