Course No. INSTR UC 355
Electronic Instrumentation and Instrumentation Technology

COMPREHENSIVE EXAMINATION (CLOSED BOOK)

Date   : 17-05-2006   Max. Marks : 75 Marks
Duration : 3 Hrs (180 mts.)   Weightage   : 25%

Note :-   1.Answer ALL Questions
               2.Make your Assumptions, if any, explicit

CAUTION: Focus your Answers to the specific points Questioned. Else u loose the time

1)

a) Draw the block diagram of a typical Electronic Instrument / Measurement system indicating all the functional elements and provide a brief account on each of the functional block w.r.t. a PMMC instrument.(say an ammeter). Indicate and define any TWO general, but very popular and significant static characteristics and TWO dynamic characteristics commonly employed to characterize a Measuring Instrument can be characterized.   (10 M)

b) While modeling the dynamic behavior of a PMMC instrument indicate as why it cannot be employed for the measurements that need to follow rapid variations. Using the dynamic model, indicate how improved *response time* and *stability* can be achieved in a typical d'Arsonval mechanism   (2.0+2.0 + 2.0 = 6 M)

c) List the sources of Error in PMMC movements and indicate how their effects can be minimized?
                                                            (4 M)

2)

a) What is the need for "SHUNT" in DC analog meters? Find value of R_{sh} when a 1 mA meter movement with R_m of 50Ω is to be used in a 0-100 mA Ammeter. Indicate constructional details and features of such a shunts and how are they used in meters   (1+1+2+1=5 M)

b) It is desired to have a multi-range ammeter i.e., with ranges 1A, 5A and 10A employing Ayrton's Shunt. Assuming that the meter is to employ a d'Arsonval movement with I_m=1mA ; R_m=50Ω; determine the three resistors R_1; R_2; R_3 that need to used and indicate the same by drawing the typical Ayrton's shunt arrangement.   (1.5+1=2.5 M)

c) List all the safety precautions to be employed while using an ammeter   (2.5 M)

3)

A bridge circuit has been employed to measure the impedance of a real capacitance (modeled as C_x in series with R_x) at a frequency of 2 KHz by connecting it in the unknown arm (say Arm 4 - an arm opposite to Arm1 and adjacent to Arm2) of the bridge. Its adjacent arm (say Arm3) consist of C_3=100 μF in series with R_3=100KΩ. The bridge is found to be in balance when the remaining set of two adjacent arms consist of R_1=10KΩ (in Arm1) and R_2=50KΩ (Arm2). Derive the Bridge Balance equations and Determine the C_x and R_x. (Bridge excitation is connected across the junction points of Arms 1&2 and Arms 3&the unknown)   (6 +4 = 10 M)

4)
   a) When should one use a Logic Analyzer OR a Scope (CRO) ? – Draw the block diagram of a Logic Analyzer and explain its operation   (1+1+3=5M)

   b) List various Frequency Synthesis Techniques. Explain The Principle of Operation of a Direct Digital Synthesis   (2+3=5M)

5)
   a) List any eight typical but very important technical specifications (as well how the spec. is expressed), as claimed by the manufacturer of an X-Y Recorder and are of at most importance for the application for which this recorder is to be employed   (4 M)

   b) What is the resolution of a $4\frac{1}{2}$ digit Digital Voltmeter. How would 12.98 V would be displayed on a 10 V range ? How would 0.6973 be displayed on 1V and 10V range ? (1+1+1.5+1.5 = 5 M)

   c) Draw the Block Diagram of a General purpose CRO and explain its operation. Indicate any FOUR front panel Controls and their function.   (2+2+2=6M)

6) Write *short notes on any FOUR* of the following: (4x2.5 = 10 M)
   i) Calibration of a Voltmeter, the Traceability Ladder and its significance
   ii) Sensitivity and Nonlinearity issues in practical HWR based meters
   iii) A Classification of various Sources of Errors in a General Measurement system and methods to reduce their effect on measurement.
   iv) The GPIB IEEE 488 Standard
   v) A comparison of the features and applications of Two wire sensing technique with those of Kelvin Sensing technique.

====)B E S T OF L U C K(====

Student Name: BITS ID No.:

BITS-Pilani Dubai Campus, Knowledge Village, Dubai

Evaluation Component : **QUIZ – 1** (closed book)

INSTR UC 355 Electronic Instruments and instrumentation Technology

Date : 11ᵗʰ May 2006   **Maximum Marks: 25**
Duration: 40 mts   **Weightage: 5%**

Note:-   1.Respond ALL questions
2. Fill the blanks, show the working and / or indicate the **"most appropriate answer"** or **"most appropriate combination of Answers"** as required for each question.
2.Make your assumptions, if any, explicit
3.All questions carry 1 mark except question No.3 & 4 which carry 2 marks each

- - -

1. The Wheatstone's bridge method of resistance measurement is ideally suitable for he measurement of resistance values in the range of   [   ]
   A) 0.001 ohm to 1 ohm
   B) 0.1 ohm to 100 ohm
   C) 100 ohm to 10 k-ohm
   D) 100 k-ohm to 10 M-ohm

2. Wagner earth devices are used in ac bridge circuits to   [   ]
   A) eliminate the effect of earth capacitance
   B) eliminate the effect of inter-component capacitances
   C) eliminate the effect of stray electrostatic fields
   D) shield the bridge elements

3. Match List-I with List-II by indicating in the braces against List II the corresponding codes (A, B, C or D) of List-I

List-I	List-II	
A.Megger	1.Measurement of loss angle in a dielectric	[ ]
B.Spectrum Aalyzer	2.Measurement of Frequency	[ ]
C.Schering bridge	3.Measurement of insulation resistance	[ ]
D.Digital Counter	4.Measurement of harmonics	[ ]

4. Match List-I with List-II by indicating in the braces against List II the corresponding codes (A, B, C or D) of List-I

List-I	List-II	
A.Audio frequency	1.Maxwell Bridge	[ ]
B.High Q indicator	2.Hay Bridge	[ ]
C.Dielectric Loss	3.Wien Bridge	[ ]
D.Low Q indicator	4.Schering Bridge	[ ]

5. The recorders that use mechanical writing devices like pen or stylus have very limited frequency response close to   [   ]
   A) 500 Hz
   B) 1 KHz
   C) 10 KHz
   D) 125 Hz

6. The main distinction between a Recorder and a Data Logger is   [   ]
    A) Recorders have data presentation device while data loggers do not have
    B) Recorders do not have a data presentation device while data loggers do have
    C) Data loggers have ability to accept greater no. of channels with better resolution
    D) Recorders have ability to accept greater no. of channels with better resolution

7. The chart speed of a recording instrument is 30 mm/s. One cycle of the signal being recorded extends over 5mm(time base). The frequency of the signal is   [   ]
    A) 10 Hz   B) 15 Hz   C) 6 Hz   D) 150 Hz

8. Most of the XY recorders employ a _____ pen positioning system

9. Width jitter is the stability of _____ edge with reference to _____ edge   [   ]
    A) Trailing , Leading
    B) Leading, Trailing
    C) Pulse trailing, previous leading

10. The ability of a Frequency Synthesis Technique in detecting the level of output spurious component and noise w.r.t. an ideal output is expressed as   [   ]
    A) Frequency Resolution
    B) Spectral Purity
    C) Tuning Bandwidth
    D) Tuning Speed.

11. What is the output frequency range in a Direct Analog Synthesizer with fin = 1MHz; fo=9MHz; Δf=1MHz; n=0 to 9 and m=0 to 9 ?   [   ]
    A) 10.0 to 19.9 MHz
    B) 100.0 to 199.9 MHz
    C) 0.1 to 1.99 MHz
    D) 1.00 to 1.99 MHz

12. In a Direct Digital Synthesis technique, if Maximum input frequency employed is 170 Hz; sampling frequency is 100 Hz; the Alias Frequency is: [   ]
    A) 70 Hz   B) 30 Hz   C) 100 Hz   D) 35 Hz

13. Assuming that an Arbitrary waveform generator employs 100 MS/s clock with a memory depth of 4000 points containing 4 cycles in its memory, the output frequency is   [   ]
    A) 25 KHz   B) 50 KHz   C)100 KHz   D)150 KHz.

14. Additional filters employed in most distortion analyzers commonly use low pass filter cut off frequencies on the order of   [   ]
    A) Few 10's of KHz
    B) Few KHz
    C) Few 100's KHz
    D) Few Hz

15. The ISA Bus employed in Data Acquisition System Support a maximum real world data transfer of about _____ theoretically but only _____ practically[   ]
    A) 10 MB/sec ; 8 MB / sec
    B) 16 MB/sec; 5 MB/sec
    C) 10 MB /sec; 5 MB / sec
    D) 16 MB/sec; 10 MB/sec

16. FFT Analyzer can be employed for   [   ]
    A) Phase analysis of transient and continuous signals
    B) Spectral plots of transient signals
    C) Vibration and Acoustic Analsis
    D) Digital storage and analysis of signals

17. One of the following is a limitation of Digital Oscilloscope. Identify it   [   ]
   A) Measurements down to dc
   B) Narrow frequency resolution
   C) Requires stable signal
   D) Spurious signals and aliasing

18. If it is required to view the signals in our system the same way as our hardware does and learn about the relationships between many signals at one glance, we can employ [   ]
   A) Digital Storage Oscilloscope
   B) Digitizing Oscilloscope
   C) FFT Analyzer
   D) Logic Analyzer

19. The timing analyzer of any Logic Analyzer is analogous to   [   ]
   A) Sampling Oscilloscope
   B) Storage Oscilloscope
   C) General Purpose Oscilloscope
   D) Digital Oscillocope

20. In a logic analyzer, if the total time data captured is 33 ms at a sampling period of 4 ns, the effective memory depth is   [   ]
   A) 144 KB
   B) 75 KB
   C) Approx. 3 KB
   D) 100 KB

21. The following does not cause a GLITCH   [   ]
   A) Capacitive coupling between traces
   B) Power supply ripples
   C) High instantaneous current demands
   D) Under sampling of signals

22. The middle layer (i.e., 3 other layers each both above and below) in an OSI model is
        [   ]
   A) Transport Layer
   B) Presentation Layer
   C) Data Link Layer
   D) Session Layer

23. The Layer with which a user observes and interacts among various layers is   [   ]
   A) The Presentation Layer
   B) The Session Layer
   C) The Application Layer
   D) The Data Link Layer

Date   : 23-04-2006   Max. Marks : 30
Duration : 50 mts.   Weightage   : 20%

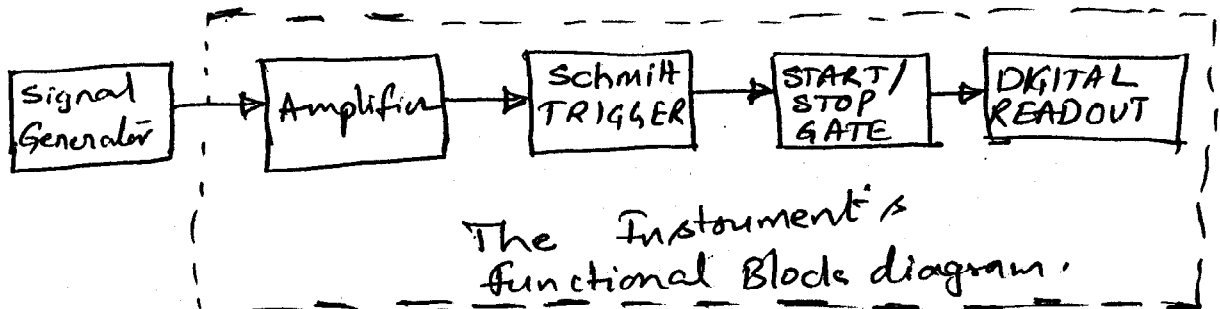Note :- 1.Answer ALL Questions
2.Make your Assumptions, if any, explicit
3.ONLY the Prescribed TEXT BOOK: "Electronic Instruments & Instrumentation Technology" by the Author:M.M.S. Anand and Instructor's ppt handouts are allowed.
CAUTION: Focus your Answers to the specific points of the Questions Else u loose time

1)

a) What is the resolution of a $3\frac{1}{2}$ digit display on i)1 V and ii)10 V ranges. How would 0.6973 V would be displayed in each of the ranges (i) and (ii)?   (1+1+1.5+1.5 = 5 M)

b) An Electronic Instrument has the following functional blocks connected as shown. Indicate the overall function of this meter and how is able to accomplish this function by explicitly mentioning the signal shape / nature at the output of each of the block and the function of each block w.r.t. overall functionality of the Instrument   (1+4 = 5 M)

2)

A bridge circuit has been employed to measure the impedance of a real capacitance (modeled as C_x in series with R_x) at a frequency of 2 KHz by connecting it in the unknown arm (say Arm 4 - an arm opposite to Arm1 and adjacent to Arm2) of the bridge. Its adjacent arm (say Arm3) consist of C_3=100 μF in series with R_3=100KΩ. The bridge is found to be in balance when the remaining set of two adjacent arms consist of R_1=10KΩ (in Arm1) and R_2=50KΩ (Arm2). Derive the Bridge Balance equations and Determine the C_x and R_x. (Bridge excitation is connected across the junction points of Arms 1&2 and Arms 3&the unknown)   (6 +4 = 10 M)

3)

a) List any eight typical but very important technical specifications (as well how the spec. is expressed), as claimed by the manufacturer of an X-Y Recorder and are of at most importance for the application for which this recorder is to be employed   (4 M)

b) Indicate the function of any THREE of the following controls on a CRO: (6 M)
i) Z modulation
ii) Astigmatism
iii) Delayed Sweep
iv) ALT / CHOP

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Student Name: BITS ID No.:

BITS-Pilani Dubai Campus, Knowledge Village, Dubai

<u>Evaluation Component :</u> **QUIZ – 1** (closed book)

INSTR UC 355 Electronic Instruments and instrumentation Technology

Date : 6th April 2006   **Maximum Marks: 50**
Duration: 40 mts   **Weightage: 5%**

Note:-   1.Respond ALL questions
2. Fill the blanks, show the working <u>and / or</u> indicate the **"most appropriate answer"** or **"most appropriate combination of Answers"** as required for each question.
2.Make your assumptions, if any, explicit
3.All questions carry 1 mark unless otherwise indicated

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1. Expression for T_D where $\underline{T_D}$ denotes <u>Deflecting Torque</u> in <u>N-m</u> of a PMMC movement is

    _____ wherein _____ denotes _____(Qty.) in _____(units)

    _____ denotes _____(Qty.) in _____(units)

    _____ denotes _____(Qty.) in _____(units)

    _____ denotes _____(Qty.) in _____(units)

2. To ensure that the turning force on the coil increases steadily, during the construction of the Meter movement _____ are employed.

3. Instrument with _____ are recommended for high vibration environments because of this mechanism's inherent stability and strength.

4. _____ is an alternate arrangement in movements to ensure inherent stability.

5. ANSI Specifications for testing of Panel meters against shock require them to be subjected to a shock of _____ during testing if the meters employ _____

6. In practice, a Metering / an Instrumentation System is designed to have _____ dynamic response in order to _____

7. The Swamping Resistors employed in series with the coil of the meter movement is to accomplish _____ and they are typically made of _____ material as it has _____

8. Following are the advantages of a PMMC instrument: _____ Scale; _____ power consumption; _____ hysteresis loss

9. Can you operate a Shunt at its full rated current ? Answer "Yes" OR "No" and justify your answer

10. How long does it take for the shunt to heat up?

11. Are the shunts linear with respect to the mill volt output across their operating range ?

12. An ac voltmeter has dc sensitivity of 10kΩ/V and ac sensitivity of 2kΩ/V. Find the input resistance of the voltmeter in the 0-10V dc range and 0-10V ac rms range.

R_{in} (in dc range) =

R_{in} (in ac range) =

13. The ac sensitivity of a voltmeter employing d'Arsonval movement is _____ than the dc sensitivity

14. The expressions to evaluate "ac" sensitivity and "dc" sensitivity of in HWR Voltmeter are

S_{dc} =

S_{ac} =

15. A 50μA meter movement with an internal resistance of 50Ω is to be used in a 0-50 V rms range in the a HWR based meter. Find the value of the required multiplier resistance.

The Value of the required multiplier resistance is : _____

16. Generally An AC meter meant to read voltage / current is calibrated to provide _____ value of the input voltage / current applied.

17. As a precautionary measure in selecting the range of a multimeter, select its final range such that it allows a reading near full scale   (state True or False)   _____

18. As a precautionary measure, Always during the setting up of the connections to a multimeter just before any measurements are taken, connect multimeter in parallel or series with the circuit
                    (state True or False)   _____

19. Never apply power to the circuit while measuring resistance with a multimeter
                    (state True or False)   _____

20. While calibrating dBm scale of a multimeter for its use as a Voltmeter, the reference voltage employed is _____ .

21. While calibrating dBm scale of a multimeter the reference impedance employed in audio circuits is _____ and that in microwave circuits is _____ .

22. The name multimeter comes from the word "_____."

23. The scale of a series type ohmmeter always has the "zero" on the _____ side of its display.

24. Draw the basic circuit of a series type Ohmmeter. Assuming a 1 mA meter movement with its internal resistance of 50Ω, calculate the values of resistors that should be employed in it in case it uses a 3V battery and it is desired to obtain half-scale deflection for 2500Ω. Also estimate the half scale deflection if the battery reduces by 10%.   (2+2+1 Marks)

25. If an instrument has ac accuracy of 0.03%; addl. error of 0.2% for crest factors between 1.414 and 5, the total accuracy for measuring a triangluar wave (crest factor = 1.73) is _____

26. Form Factor is the Ratio of _____ value of a signal to _____ value

27. The input "LO" of an instrument must always be connected to the _____ point of the circuit under test to minimize _____.

28. An Instrument specification indicates 1% uncertainty. This implies that the instrument's accuracy is _____.

29. If we are monitoring a constant voltage of 1V, and notice that the measured value changes by 20 mV between measurements, then the measurement precision is _____

30. In a peak to peak reading voltmeter, to ensure proper circuit operation, a large value of "RC" required at _____ freq. of operation to ensure proper circuit operation

31. In an electrodynamometer movement, the deflection torque is proportional to _____ of the current through the movement.

32. The Moving Iron Movement works on the principle of : _____.

33. The typical input impedance of OPAMPs employed in Input switching and range selection block of an Electronic DC Voltemeter is of the order of _____.

34. The main disadvantage of employing Four wire sensing in Multi channel Electronic Analog ohmmeters is: _____.

35. In Analog Storage CROs, The storage is accomplished employing the principle of _____.

36. The secondary electron guns of an analog storage CRO are called _____.

37. The CRTs of ancient analog CROs are replaced in modern CROs by _____.

38. The major disadvantage of a PC Based CRO to the owner is that _____ _____.

3

39. In Digital Phosphor Oscilloscope, the Digital Phosphor is nothing but, _____
_____ of the scope's display

40. White light emitting diodes are usually _____ LEDs with a coating of a suitable phosphor.

41. _____ activated with _____ is used as red phosphor in color color CRTs of Digital Storage CROs

42. Employing Wheatstone's bridge Resistance measurements can be made with an accuracy of _____ %.

43. _____ is often preferred and employed over Wheatstone's bridge for the measurement of resistances of samples of shunt resistances of meters.

44. Typically a Maxwell bridge contain _____ and _____ in the remaining two arms other than the two arms containing resistive elements.

45. Indicate the elements that a Shering Bridge contain in each of its four arms.
Arm1: _____ Arm2: _____
Arm3: _____ Arm4: _____

46. The bandwidth specification of a CRO precisely signify: _____
_____
_____

Space for Rough work if any:

4

Date   : 12-03-2006   Max. Marks   : 30

Duration : 50 mts.   Weightage   : 20%

Note :-   1.Answer ALL Questions

           2.Make your Assumptions, if any, explicit

CAUTION: Focus your Answers to the specific points of the Questioned. Else the u loose time

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1)

   a) Draw the block diagram of a typical Electronic Instrument / Measurement system indicating all the functional elements and provide a brief account on each of the functional block w.r.t. a PMMC instrument.(say an ammeter)   (4 M)

   b) While modeling the dynamic behavior of a PMMC instrument indicate as why it cannot be employed for the measurements that need to follow rapid variations. Using the dynamic model, indicate how improved *response time* and *stability* can be achieved in a typical d'Arsonval mechanism   (1.0+1.0 + 1.0 = 3 M)

   c) List the sources of Error in PMMC movements and indicate how their effects can be minimized?   (3 M)

2)

   a) What is the need for "SHUNT" in DC analog meters? Find value of R_{sh} when a 1 mA meter movement with R_m of 50Ω is to be used in a 0-100 mA Ammeter. Indicate constructional details and features of such a shunts and how are they used in meters   (1+1+2+1=5 M)

   b) It is desired to have a multi-range ammeter i.e., with ranges 1A, 5A and 10A employing Ayrton's Shunt. Assuming that the meter is to employ a d'Arsonval movement with I_m=1mA ; R_m=50Ω; determine the three resistors R_1; R_2; R_3 that need to used and indicate the same by drawing the typical Ayrton's shunt arrangement.   (1.5+1=2.5 M)

   c) List all the safety precautions to be employed while using an ammeter   (2.5 M)

3)

   a) Draw the basic Arrangement that can be employed in a typical shunt type ohmmeter and explain how it works. Also arrive at mathematical expressions that enable us to design of various circuit elements involved in it.   (1+1+2 = 4 Marks)

   b) Write *short notes on any THREE* of the following: (3x2M = 6 M)

      i) Calibration of a Voltmeter, the Traceability Ladder and its significance

      ii) Sensitivity and Nonlinearity issues in practical HWR based meters

      iii) Inter-Relationships between Resistance, Capacitance and Frequency in a peak reading Voltmeter and their effect on its performance

      iv) A comparison of PMMC movement with Moving Iron (Vane) meter movement

      v) Kelvin Sensing Technique

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