I. K. GUJRAL PUNJAB TECHNICAL UNIVERSITY JALANDHAR

QUESTION PAPER Ph.D. ENTRANCE TEST-2024

Time: 120 Minutes **Max Marks: 100**

Discipline: Electronics & Communication Engineering Sr. No.

Name: …….. Father's Name: …….

Roll Number: …….. Roll No. in words:……..

Discipline:…… Date:……

Signature of candidate:…….. Signature of Invigilator: ……...

INSTRUCTIONS FOR CANDIDATES

1. Do not open seal before start of exam.
2. Question paper consists of two sections. Section-I is discipline specific and Section-II is of Research Methodology. Each section contains 50 multiple choice questions. Total 100 questions of one mark each.
3. Please check your question paper and answer sheet pages and report for any damaged or missing page, before attempting and report the same to invigilator immediately.
4. Carefully fill all your details in top portion of this question paper. Don't leave any column blank.
5. Use blue/black ball point pen to fill details on question paper and answer sheet. Using pencil is strictly prohibited. Write only in capital letters.
6. Carefully fill all the details and signatures on top portion of answer sheet.
7. Qualifying marks shall be 50% for General Category and 45% for Reserved Categories.
8. All questions are compulsory. No negative marking for wrong answers.
9. There are four alternative answer options (A, D, C and D) for each question out of which only one is correct.
10. Write A or B or C or D or E as answer against the question number as per correct choice on the provided Answer Sheet using pen. If the candidate does not want to attempt the Question, then he/she must mark option (E) in the available choice i.e. Not Attempted.
11. Questions left blank or attempted with two or more options/answers will not be evaluated.
12. Do not use marker or white fluid on the answer sheet.
13. The medium of the examination is English only.
14. No extra sheet will be provided for the rough work. Use the space inside the question paper pages for rough work.
15. Carrying mobile phones, calculators, electronic gadgets, notes or extra papers in examination hall is strictly prohibited.
16. Log tables may be provided for calculation work, if required.
17. Indulging in any form of unfair means, canvassing, impersonation or misbehavior with examination staff will result in disqualification of your candidature.

Do not open seal before start of exam

SECTION I (ELECTRONICS AND COMMUNICATION ENGINEERING)

1) A band-limited signal with a maximum frequency of 10 kHz is to be sampled. According to the sampling theorem, which of the following sampling frequency is not valid:

   A) 15 KHz

   B) 20 KHz

   C) 25 KHz

   D) 30 KHz

2) Match corresponding spectral characteristic with the signal types -

	Signal Type		Spectral Characteristics
(1)	Continuous and periodic	(a)	Discrete and periodic
(2)	Continuous and aperiodic	(b)	Continuous and periodic
(3)	Discrete and periodic	(c)	Continuous and aperiodic
(4)	Discrete and aperiodic	(d)	Discrete and aperiodic

   A) (1) → (b), (2) → (a), (3) → (c), (4) → (d)

   B) (1) → (c), (2) → (b), (3) → (d), (4) → (a)

   C) (1) → (d), (2) → (c), (3) → (a), (4) → (b)

   D) (1) → (a), (2) → (b), (3) → (d), (4) → (c)

3) Which of the following is true for the function $f(t) = sin^2t + cos2t$?

   A) f has frequency components at 0 and $1/2\pi$ Hz

   B) f has frequency components at 0 and $1/\pi$ Hz

   C) f has frequency components at $1/2\pi$ and $1/\pi$ Hz

   D) f has frequency components at 0, $1/2\pi$ and $1/\pi$ Hz

4) The bilateral Laplace transform of a function $f(t) = \begin{cases} 1 \; if \; p \le t \le q \\ 0 \quad otherwise \end{cases}$ is given by

   A) $\frac{p-q}{s}$

   B) $\frac{e^s(p-q)}{s}$

   C) $\frac{e^s(p+q)}{s}$

   D) $\frac{e^{-ps}-e^{-qs}}{s}$

5) Norton's theorem states that a complex network connected to a load can be replaced with an equivalent impedance:

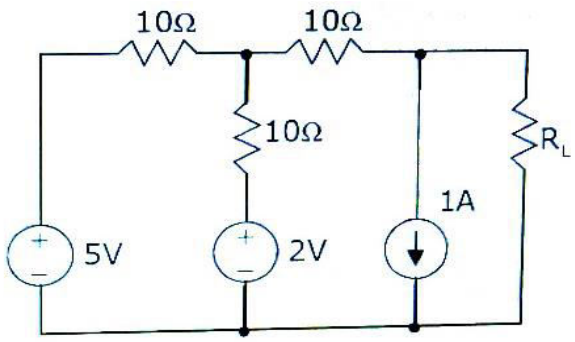
   A) in series with a current source

   B) in parallel with a current source

   C) in series with a voltage source

   D) in parallel with a voltage source

6) In the circuit shown below, the value of R_L for maximum power transfer is



A) 15Ω

B) 10Ω

C) 5Ω

D) 20Ω

7) Octal equivalent of $(AB.DC)_{16}$ is

A) 253.374

B) 235.760

C) 253.670

D) 235.670

8) The Boolean expression $AB + AC' + BC$ simplifies to (A' represents complement of A):

A) $AB + AC' + B$

B) $A'B + AC'$

C) $AB + BC$

D) $AC' + BC$

9) Total capacity of a SRAM having address lines A0 to A15 and data width D0-D7 is

A) 128 KB

B) 64 KB

C) 32 KB

D) 16 KB

10) Each cell of a Static Random Access Memory (SRAM) contains

A) 6 MOS transistors

B) 4 MOS transistors and 2 capacitors

C) 2 MOS transistors and 4 capacitors

D) 4 MOS transistors

11) The resolution of a 4-bit counter type ADC is 0.5 Volts. For an analog input of 6.6 Volts, the digital output of the ADC will be

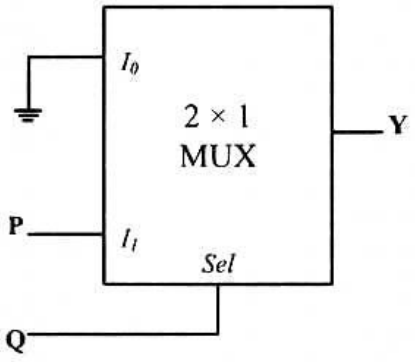
A) 1010

B) 1100

C) 0011

D) 1110

12) In the circuit shown below, P and Q are the inputs. The logical function realized by the circuit shown below is



A) $Y = PQ$

B) $Y = P + Q$

C) $Y = \overline{P + Q}$

D) $Y = \overline{PQ}$

13) A region of negative differential resistance is observed in the current voltage characteristics of a silicon PN junction if

A) The N-region is heavily doped compared to the P-region

B) Both N and P regions are heavily doped

C) The P-region is heavily doped compared to the N-region

D) An intrinsic silicon region is inserted between N and P region

14) Which of the following statements best describes the Early effect in a bipolar junction transistor (BJT)?

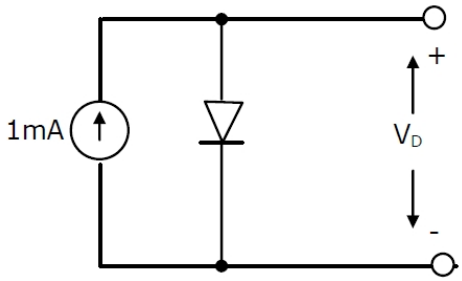
A) It causes the base-emitter voltage to decrease with increasing collector current.

B) It results in a reduction of collector current with increasing collector-emitter voltage.

C) It leads to increase in the width of base region as collector-emitter voltage increases.

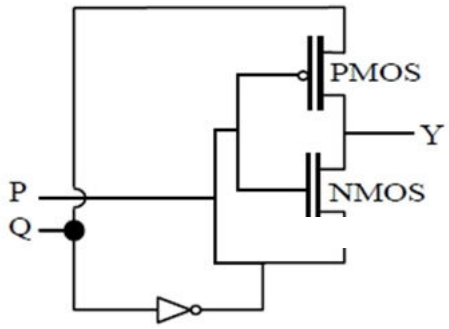
D) It causes slight increase in collector current with increasing collector-emitter voltage.

15) In the figure, a silicon diode is carrying a constant current of 1 mA. When the temperature of the diode is 20°C, V_D is found to be 700 mV. If the temperature rises to 40°C, V_D becomes approximately equal to



A) 740 mV
B) 660 mV
C) 680 mV
D) 700 mV

16) Identify the circuit shown in the figure given below, where P and Q are the inputs and Y is the output.



A) OR
B) AND
C) XOR
D) XNOR

17) Which of the following correctly describes non-degenerately doped n-type silicon?
A) The Fermi level is inside the conduction band, and the material behaves like a metal.
B) The Fermi level is closer to the conduction band but remains within the bandgap, and the material behaves as a semiconductor.
C) The Fermi level is at the midpoint of the bandgap, similar to intrinsic silicon.
D) The doping concentration is so high that the number of free electrons does not depend on temperature.

18) Which of the following correctly describes the operating characteristics of LEDs and photodiodes?

A) LEDs emit light, while photodiodes detect light when reverse biased.

B) LEDs emit light when forward biased, while photodiodes generate current when exposed to light and forward biased.

C) LEDs emit light when forward biased, while photodiodes generate current when exposed to light and reverse biased.

D) LEDs detect light when forward biased, while photodiodes emit light when reverse biased.

19) For an LED to emit light in visible region of electromagnetic spectrum, it should have energy band gap in the range of

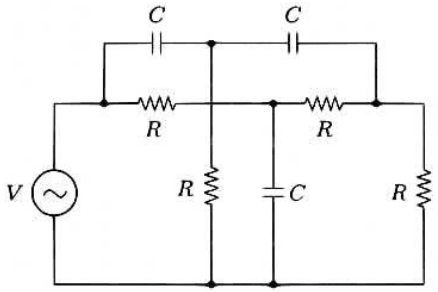
A) 0.3eV to 0.8eV

B) 0.8 eV to 1.6eV

C) 1.8 eV to 2.4 eV

D) 3.0 eV to 3.9 eV

20) The minimum number of equations required to analyze the circuit shown in Fig. is:



A) 5

B) 4

C) 7

D) 3

21) If the signal-to-noise ratio (SNR) is infinitely large, the channel capacity:

A) Reaches a finite maximum

B) Approaches zero

C) Increases indefinitely

D) Remains unaffected

22) Generally, the gain of a transistor amplifier falls at high frequency due to the

A) Parasitic capacitances within the transistor and amplifier circuit

B) Coupling capacitor at the input of the amplifier circuit

C) Skin effects

D) Coupling capacitor at the output of the amplifier circuit

23) An n-p-n bipolar junction transistor (BJT) is operating in the active region. If reverse bias across the collector-base junction is increased, then

A) Effective base width increases and common emitter current gain increases

B) Effective base width decreases and common emitter current gain decreases

C) Effective base width decreases and common emitter current gain increases

D) Effective base width increases and common emitter current gain increases

24) In comparison to N-channel MOSFET, CMOS amplifier has the advantage of:

A) Lower drain current and lesser power consumption

B) Higher voltage gain and lower cut-off frequency

C) Higher current gain and higher cut-off frequency

D) All of the above

25) What is the effect of increasing the length of the signal on the autocorrelation function?

A) The autocorrelation function becomes less accurate.

B) The autocorrelation function becomes more sensitive to high-frequency components.

C) The autocorrelation function can provide more detailed information about periodicity.

D) The autocorrelation function becomes independent of the signal length.

26) The impulse response of an LTI system can be obtained by

A) Differentiating the unit ramp response

B) Integrating the unit ramp response

C) Differentiating the unit step response

D) Integrating the unit step response

27) Negative feedback in an electronic system typically leads to:

A) Increased gain and decreased bandwidth.

B) Increased stability and reduced gain variation.

C) Improved signal-to-noise ratio.

D) Decreased input impedance and increased output impedance.

28) The poles of the transfer function G(s) are related to:

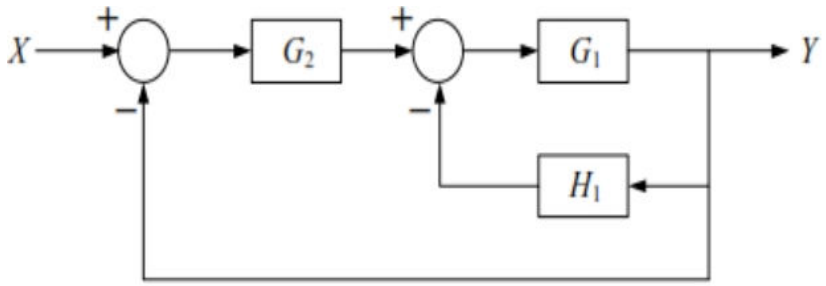
A) Stability of the system

B) Frequency response

C) Gain margin

D) Phase margin

29) The block diagram of a feedback control system is shown in the figure. The overall closed-loop gain G of the system is



A) $G = \frac{G_1 G_2}{1+G_1 H_1}$

B) $G = \frac{G_1 G_2}{1+G_1 G_2+G_1 H_1}$

C) $G = \frac{G_1 G_2}{1+G_1 G_2 H_1}$

D) $G = \frac{G_1 G_2}{1+G_1 G_2+G_1 G_2 H_1}$

30) In the context of Signal Flow Graphs, Mason's Gain Formula is used –

A) To determine the time-domain response of a system.

B) To calculate the overall transfer function from the input to the output of the system.

C) To measure the system's stability directly.

D) To compute the frequency response of the system.

31) In a practical control system, why might a lead compensator be used over a lag compensator?

A) To reduce steady-state error more effectively than a lag compensator.

B) To improve transient response and system stability, especially when a fast response is needed.

C) To increase the steady-state error and make the system less sensitive to disturbances.

D) To decrease the system bandwidth and reduce the high-frequency noise.

32) The transfer function of a first-order controller is given as $G_C(s) = \frac{K(s+a)}{s+b}$, where K, a and b are positive real numbers. The condition for this controller to act as a phase lead compensator is

A) $a < b$

B) $a > b$

C) $K < ab$

D) $K > ab$

33) For an n-order Butterworth filter, the magnitude response is:

A) Proportional to $1/\sqrt{1 + (\omega/\omega_c)^{2n}}$

B) Proportional to $1/\sqrt{1 + (\omega/\omega_c)^{n}}$

C) Proportional to ω^n

D) Proportional to ω_c/ω

34) Which of the following points is NOT on the root locus of a system with the open loop transfer function $G(s)H(s) = \frac{K}{s(s+1)(s+3)}$

A) $s = -j\sqrt{3}$

B) $s = -1.5$

C) $s = -3$

D) $s = -\infty$

35) Faraday's law of electromagnetic induction is mathematically described by which one of the following equations?

A) $\nabla \cdot \vec{B} = 0$

B) $\nabla \cdot \vec{D} = \rho_v$

C) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

D) $\nabla \times \vec{H} = \sigma\vec{E} + \frac{\partial \vec{D}}{\partial t}$

36) The divergence of the vector field $\vec{A} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$ is

A) 0

B) 3

C) 1/3

D) 1

37) A coaxial cable with an inner diameter of 1 mm and outer diameter of 2.4 mm is filled with a dielectric of relative permittivity 10.89. Given $\mu_0 = 4\pi \times 10^{-7}\,\mathrm{H/m}$, $\varepsilon_0 = \frac{10^{-9}}{36\pi}\,\mathrm{F/m}$, the characteristic impedance of the cable is

A) 330Ω

B) 100Ω

C) 15.9Ω

D) 143.3Ω

38) The VSWR can have any value between

A) 0 and 1

B) -1 and +1

C) 0 and ∞

D) 1 and ∞

39) In an impedance Smith chart, a clockwise movement along a constant resistance circle gives rise to

A) A decrease in reactance, moving from inductive to capacitive.

B) An increase in reactance, moving from capacitive to inductive.

C) A decrease in resistance, moving from higher to lower resistance.

D) An increase in resistance, moving from lower to higher resistance.

40) The directivity of an antenna can be increased by adding more antenna elements. How does increasing the number of elements affect the antenna characteristics?

A) Decreases the gain and widens the beamwidth

B) Increases the gain and narrows the beamwidth

C) Decreases both gain and beamwidth

D) Increases both gain and beamwidth

41) Sensitivity of a super-heterodyne radio receiver mainly depends upon the:

A) RF amplifier stage

B) IF amplifier stage

C) IF & AF amplifier stage

D) All of the above

42) Consider an FM signal $f(t) = \cos[2\pi f_c t + \beta_1 \sin 2\pi f_1 t + \beta_2 \sin 2\pi f_2 t]$. The maximum deviation of the instantaneous frequency from the carrier frequency f_c is

A) $\beta_1 + \beta_2$

B) $\beta_1 f_1 + \beta_2$

C) $\beta_1 f_1 + \beta_2 f_2$

D) $\beta_1 f_2 + \beta_2 f_1$

43) The modulation scheme commonly used for transmission from GSM mobile terminals is

A) 4-QAM

B) 16-PSK

C) Walsh-Hadamard orthogonal codes

D) Gaussian Minimum Shift Keying

44) The bit rate of a digital communication system is R kbits/s. The modulation used is 32-QAM. The minimum bandwidth required for ISI free transmission is

A) R/5 KHz

B) R/5 Hz

C) R/10 Hz

D) R/10 KHz

45) If the number of bits per sample in a PCM system is increased from n to n+1, the improvement in signal-to-quantization noise ratio will be

A) 2n dB

B) N dB

C) 3dB

D) 6 dB

46) Two independent random variable X and Y are uniformly distributed in the interval [-1, 1]. The probability that $max[X, Y]$ is less than 1/2 is

A) 3/4

B) 9/16

C) 1/2

D) 2/3

47) In a base band communications link, frequencies up to 3500 Hz are used for signaling. Using a raised cosine pulse with 75% excess bandwidth and for no inter-symbol interference, the maximum possible signaling rate in symbols per second is

A) 1850

B) 2550

C) 3225

D) 4000

48) The rank of the matrix $\mathrm{M} = \begin{bmatrix} 5 & 10 & 10 \\ 1 & 0 & 2 \\ 3 & 6 & 6 \end{bmatrix}$ is

A) 0

B) 1

C) 2

D) 3

49) Manu and Tanu appeared in an interview for two vacancies in the same department. The probability of Manu's selection is 1/6 and that of Tanu is 1/8. What is the probability that only one of them will be selected?

A) 1/4

B) 47/48

C) 13/48

D) 35/48

50) The general solution of the differential equation $\frac{dy}{dx} = \frac{1+\cos 2y}{1-\cos 2x}$ is

A) $\tan y - \cot x = C$

B) $\tan x - \cot y = C$

C) $\tan y + \cot x = C$

D) $\tan x + \cot y = C$

SECTION II (RESEARCH METHODOLOGY)

51. Research is underpinned by:

A) A framework of philosophy

B) Methods that have been tested for validity and reliability

C) Ethical frameworks

D) All of the above

52. Which of the following is not a characteristic or requirement for the research process?

A) Controlled.

B) Empirical.

C) Radical.

D) Critical

53. Which option is least related to a qualitative research

A) Open

B) Unstructured

C) Flexible

D) Numerical

54. Which option is not associated with a quantitative approach?

A) Rigid

B) Narrative

C) Predetermined

D) Structured

55. In _____ the main purpose is to formulate a problem for more precise investigation

A) Descriptive Study

B) Diagnostic Study

C) Exploratory Study

D) None of the above

56. _____ prevent a researcher from blind research and intellectual wandering

A) Research Design

B) Research Tools

C) Data

D) Sample

57. Date related to geophysical characteristic is called

A) Organizational Data

B) Demographic Data

C) Territorial Data

D) Personal Data

58. The aggregate of all the units pertaining to a study is called

A) Frame

B) Sample

C) Unit

D) Population

59, A statistical measure based upon the entire population is called parameter while measure based upon the sample is called

A) Sample Parameter

B) Inference

C) Statistic

D) None of the above

60. Survey study aims at

i) Knowing Facts about the two existing situations

ii) Comparing the present status with the standard norms

iii) Criticizing the existing situation

iv) Identifying the means of improving the existing situation

A) i) and ii) only

B) i), ii) and iii) only

C) i), ii), iii) and iv)

D) ii) and iii) only

61. The independent variable refers to

A) A variable which serves as the aim of an experiment

B) The variable being manipulated or varied in some way by the researcher

C) The variable which is only used in the control condition

D) The variable which shows us the effect of the manipulation

62. Which of the following statements is correct?

A) Variability is the source of the problem

B) Researcher must possess analytical ability

C) Objectives of the research are stated in the first chapter of the thesis

D) All the above

63. In the process of conducting research "Formulation of Hypothesis" is followed by

A) Analysis of data

B) Collection of data

C) Statement of objectives

D) Selection of research tools

64. If in a research independent variable cannot be manipulated then it is known as

A) Experimental research

B) Non-experimental research

C) Pure or fundamental research

D) Exploratory research

65. If a researcher is studying the effect of using laptops in his classroom to ascertain their merit and worth; he is likely conducting which of the following types of research?

A) Experimental

B) Applied

C) Basic

D) Evaluation

66. A measure is reliable if it provides consistent _____

A) Hypothesis

B) Results

C) Procedure

D) Sensitivity

67. "Officers in my organization have higher than average level of commitment" such a hypothesis is an example of

A) Descriptive hypothesis

B) Directional hypothesis

C) Relational hypothesis

D) All of the above

68. Formulation of hypothesis may not be necessary in

A) Survey studies

B) Fact finding (historical) studies

C) Experimental studies

D) Normative studies

69. …… is concerned with discovering and testing certain variables with respect to their association or disassociation

A) Exploratory

B) Descriptive

C) Diagnostic

D) Descriptive and diagnostic

70. The main objective of …….. study's to acquire knowledge

A) Exploratory

B) Descriptive

C) Diagnostic

D) Descriptive and Diagnostic

71. A statement of the quantitative research question should:

A) Extend the statement of purpose by specifying exactly the question (s the researcher will address

B) Help the research in selecting appropriate participants, research methods, measures, and materials

C) Specify the variables of interest

D) All the above

72. A _____ is a subset of a _____.

A) Sample, population

B) Population, sample

C) Statistic, parameter

D) Parameter, statistic

73. A good hypothesis should be

A) Precise, specific and consistent with known facts

B) Formulated in such a way that it can be tested by the data

C) Limited scope and should not have global significance

D) All of these

74. Which of the following is true regarding research objectives?

A) Research objectives, when achieved, will provide sufficient earnings to obtain a reasonable return on investment.

B) Research objectives, when obtained, will ensure the viability of the marketing research department.

C) Research objectives, when achieved, provide the information necessary to solve the problem.

D) Research objectives are seldom achieved but should be stated as goals to be sought.

75. Your colleague is confused about using the marketing research process, as he knows that something is wrong but is not sure of the specific causes to investigate. He seems to be having problems with _____, which is often the hardest step to take.

A) Developing the research plan

B) Determining a research approach

C) Defining the problem and research objectives

D) Selecting a research agency

76. What is the primary goal of data visualization?

A) To collect more data

B) To represent data accurately

C) To make data more accessible and understandable

D) To hide data from the audience

77. Which of the following is NOT a common visual element used in data visualization?

A) Bar chart

B) Line chart

C) Data table

D) Pie chart

78. Which type of data visualization is best suited for showing the distribution of a single numerical variable?

A) Bar chart

B) Line chart

C) Scatter plot

D) Pie chart

79. Which data visualization is commonly used to show the relationship between two numerical variables?

A) Bar chart

B) Line chart

C) Scatter plot

D) Pie chart

80. What is the purpose of “legend” in data visualization?

A) Explain the meaning of colours or symbols in a chart

B) Provides data context

C) Represent the main context

D) Adds decorative elements

81. What type of chart is useful for showing trends or changes over time?

A) Pie chart

B) Column chart

C) Line chart

D) Dot graph

82. If the mean of five observations is 20, and one of them is 24, what is the mean of the remaining four observations?

A) 16

B) 18

C) 20

D) 22

83. The sum of deviations of a set of observations from their mean is always:

A) Zero

B) Negative

C) Positive

D) Undefined

84. The value which occurs most frequently in a set of observations is called:

A) Mean

B) Mode

C) Median

D) None of the above

85. The formula to find the median of a set of observations is:

A) $\frac{(n+1)}{2}$

B) $\frac{(n-1)}{2}$

C) $\frac{n}{2}$

D) None of the above

86. The interquartile range is defined as the difference between:

A) The third and first quartiles

B) The maximum and minimum values

C) The mean and median

D) The second and third quartiles

87. The coefficient of variation is the ratio of the standard deviation to the:

A) Arithmetic mean

B) Geometric mean

C) Harmonic mean

D) Median

88. The range of a data set is:

A) The difference between the largest and smallest values in the set

B) The sum of all the values in the set

C) The product of all the values in the set

D) None of the above

89. If the mode of a data set is 10, and the mean is 15, what can be said about the shape of the distribution?

A) Skewed left

B) Skewed right

C) Symmetrical

D) Cannot be determined

90. The abscissa of the point of intersection of the less than type and of the more than type cumulative frequency of a grouped data gives its:

A) Mean

B) Median

C) Mode

D) All of these

91. If the mean of first n natural numbers is 5n/9, then n =?

A) 6

B) 7

C) 9

D) 10

92. If 35 is removed from the data, 30, 34, 35, 36, 37, 38, 39, 40 then the median increases by:

A) 2

B) 1.5

C) 1

D) 0.5

93. The Median when it is given that mode and mean are 8 and 9 respectively, is:

A) 8.57

B) 8.67

C) 8.97

D) 9.24

94. There are lottery tickets labelled with numbers from 1 to 500. I want to find the number which is most common in lottery tickets. What quantity do I need to use?

A) Mode

B) Mean

C) Median

D) None of the above

95. Which of the following is not a measure of central tendency?

A) Mode

B) Range

C) Median

D) Mean

96. The mean of 4 numbers is 37. The mean of the smallest three of them is 34. If the range of data is 15, what is the mean of largest three?

A) 41

B) 38

C) 40

D) 39

97. Which of the following can not be determined graphically?

A) Mean

B) Median

C) Mode

D) None of these

98. The median of set of 9 distinct observations is 20.5. If each of the largest 4 observations of the set is increased by 2, then the median of the new set

A) is increased by 2

B) is decreased by 2

C) is two times of the original number

D) Remains the same as that of the original set.

99. Let $a, b \in R$. Let the mean and variance of 6 observations -3, 4, 7, -6, a, b be 2 and 23, respectively. The mean deviation about the mean of these 6 observations is:

A) 13/3

B) 16/3

C) 11/3

D) 14/3

100. If mean of 25, 29, 25, 32, 24 and x is 27, then what will be the median?

A) 32

B) 27

C) 26

D) 25