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PD - 34

Total No. of Pages : 20

Ph.d Entrance Examination March/April, 2026

CIVIL ENGINEERING

Subject Code : 58746

Day and Date : Tuesday, 06-10-2026

Total Marks : 100

Time : 04.00 p.m. to 06.00 p.m.

Instructions :

- 1) All questions are compulsory.
- 2) Each question carries 2 marks.
- 3) Answers should be marked in the given OMR answer sheet by darkening the appropriate option.
- 4) Use black ball point pen only for marking the circle. Do not make any stray mark on the OMR answer sheet.
- 5) Follow the instructions given on OMR Sheet.
- 6) Rough work shall be done on the sheet provided at the end of question paper.
- 7) Only non-programmable calculators are allowed.

1. Which type of research writing is primarily written before a research project begins to outline the objectives, methodology, and expected outcomes to secure funding or approval?

A) Research Proposal

B) Research Article

C) Review Paper

D) Research Thesis
2. A civil engineering researcher wants to study the compressive strength of concrete produced across a state. They divide the state into different geographic regions (strata) based on climatic conditions and randomly select concrete cube samples from each region to ensure all environmental zones are accurately represented. Which sampling technique is the researcher using?

- A) Simple Random Sampling B) Stratified Random Sampling
C) Convenience Sampling D) Snowball Sampling
3. In analytical civil engineering research (such as concrete strength or soil compaction testing). which statistical measure is primarily reported in the text to demonstrate the dispersion, spread, or variability of the experimental data points around their calculated arithmetic mean?
- A) Median B) Mode
C) Standard Deviation D) Range
4. When reporting statistical hypothesis testing in a research paper, a p-value of less than the standard significance level (e.g., $p < 0.05$) mathematically implies which of the following outcomes?
- A) The null hypothesis is accepted, indicating no significant difference.
B) The null hypothesis is rejected, indicating a statistically significant difference.
C) The experimental sample size was too small to make a conclusion.
D) There is a human calculation or entry error in the primary data.
5. Which of the following statistical tests is a parametric test used to compare the means of two independent groups?
- A) Mann-Whitney U test B) Two-sample t-test
C) Wilcoxon signed-rank test D) Kruskal-Wallis test
6. Non-parametric tests are primarily used when the data being analyzed does not meet which of the following conditions?
- A) The data is normally distributed.
B) The sample size is extremely large.
C) The data is measured on a nominal scale.
D) The groups being compared are independent.

7. In Civil Engineering research, when a researcher wants to compare the average compressive strength of concrete mixes prepared using four different types of recycled aggregates, which statistical test is most appropriate?
- A) One-Way ANOVA B) Student's t-test
C) Chi-Square test D) Linear Regression
8. Which of the following multivariate analysis techniques is primarily used to reduce the dimensionality of a large dataset while retaining as much variance as possible?
- A) Principal Component Analysis (PCA)
B) Cluster Analysis
C) Multiple Linear Regression
D) Logistic Regression
9. In research metrics, if a civil engineering researcher has an h-index of 12, what does this primarily signify?
- A) The researcher has published at least 12 papers, each of which has received at least 12 citations.
B) The researcher has published a total of 12 papers in their career.
C) The researcher's most popular paper has been cited exactly 12 times.
D) The average number of citations per paper for this researcher is 12.
10. In an engineering research experiment investigating the tensile strength of a new composite material, a researcher tightly controls environmental factors like temperature, humidity, and machine calibration to isolate the exact cause of failure. While this strengthens the study's internal validity, it potentially compromises its:

- A) Construct validity
 - B) External validity
 - C) Content validity
 - D) Criterion validity
11. A research team wants to study the performance of a routing algorithm under three different traffic conditions. However, due to practical constraints, they cannot randomly assign network nodes into true control and experimental groups. Instead, they must use naturally existing network clusters. What type of research design is being conceptualized?
- A) True Experimental Design
 - B) Quasi-Experimental Design
 - C) Descriptive Design
 - D) Ex-Post Facto Design
12. During the conceptualization stage, a researcher defines "System Latency" not merely as a concept, but specifically as "the time elapsed in milliseconds from the execution of an input packet to the generation of the corresponding output signal." This methodological step is formally known as:
- A) Hypothesis Refinement
 - B) Conceptual Framework Modeling
 - C) Operationalization of Variables
 - D) Triangulation
13. An engineering education researcher intends to evaluate a new project-based curriculum. They design the study to first collect statistical performance data from all student cohorts, followed by conducting selective, deep-dive interviews with outliers to explain why specific anomalies occurred in the data. According to research design notations, this framework is a/an:

- A) Exploratory Sequential Design
 - B) Convergent Parallel Design
 - C) Explanatory Sequential Design
 - D) Embedded Experimental Design
14. A researcher wants to study the structural behavior of a newly developed carbon-fiber-reinforced concrete beam under fatigue loading to solve immediate micro-cracking issues reported in a signature bridge project. What type of research is being primarily conducted?
- A) Fundamental Research
 - B) Applied Research
 - C) Historical Research
 - D) Exploratory Research
15. An environmental engineering researcher collects dissolved oxygen (DO) and biochemical oxygen demand (BOD) data across 50 different locations along a river basin at a single specific week of the year to analyze current pollution levels. This study is best classified as a:
- A) Longitudinal Study
 - B) Experimental Study
 - C) Cross-sectional Study
 - D) Fundamental Study
16. In a concrete quality control assessment for a major highway project spanning multiple regions, the quality control engineer decides to split the concrete cube test data into distinct groups based on the grading of the concrete ((M25, M30, \text{ and M40\})) before performing random selection. This is done because the strength characteristics vary significantly between grades but are relatively consistent within each grade. Which of the following statements is correct regarding this sampling approach?

- A) The population is homogeneous, and cluster sampling would be more efficient.
 - B) The population is heterogeneous, and stratified random sampling is chosen because it minimizes intra-strata variance and maximizes inter-strata variance.
 - C) This represents systematic sampling since a fixed interval is maintained between samples.
 - D) This is a non-probability quota sampling technique since the engineer defines the categories.
17. An environmental engineer needs to evaluate the daily concentration of Total Suspended Solids (TSS) in a municipal wastewater treatment plant's effluent. The engineer decides to take a sample every 7th day at 10:00 AM over a period of 6 months.

What is the primary technical risk or bias associated with this systematic sampling setup?

- A) It is a non-probability sampling technique, so statistical generalization is impossible.
- B) It introduces high selection bias because a random starting point cannot be utilized.
- C) It is susceptible to periodicity error (or cyclical bias) if the underlying pollutant concentration follows a weekly cyclical pattern.
- D) It requires an infinitely large sample size compared to simple random sampling.

18. To test your understanding, let's try a quick practice problem:
- A geotechnical engineer wants to sample soil strata along a 10 km linear highway alignment. If they select a random starting point at 150 meters and then take a core sample every 500 meters sequentially (at 650m, 1150m, 1650m, etc.), what specific sampling technique are they employing?
- A) Cluster Sampling B) Stratified Sampling
C) Systematic Sampling D) None of the above
19. A structural engineering researcher wants to evaluate the long-term durability of a newly developed self-healing concrete. Before commencing lab experiments, they perform a comprehensive literature review. Which of the following best represents the primary scientific objective of this literature review?
- A) To extract raw data from previous charts to directly use as their own experimental control group.
B) To identify conflicting findings or unaddressed variables (gaps) in existing self-healing concrete studies to justify the new methodology.
C) To prove that all previously published methodologies regarding concrete durability are fundamentally flawed.
D) To compile a chronological list of definitions for every material component used in the mix design.
20. While drafting the literature review section of an MTech thesis on "Traffic Congestion Modeling using AI", a student directly copies three consecutive sentences explaining an optimization. algorithm from a peer-reviewed transportation journal. They include the original author's name and publication year at the end of the paragraph but do not use quotation marks. This scenario is an example of:

- A) Proper and ethical academic synthesis since the source was credited at the end.
 - B) Securing a strong background context by relying on verified, high-quality journal text.
 - C) Plagiarism, because verbatim text must be explicitly enclosed in quotation marks or block-indented, even if cited.
 - D) Standard narrative literature review structuring that does not require structural adjustments.
21. In a structured technical research report evaluating the structural health monitoring of a bridge, where should the detailed sensor calibration data, raw strain gauge logs, and extensive material testing mathematical derivations be placed?
- A) Within the main Body of Results and Discussion
 - B) Integrated directly into the Methodology section
 - C) In the Appendices at the end of the report
 - D) Immediately following the Abstract as supplementary data.
22. When drafting a technical research paper on the optimization of a high-performance concrete mix design, which of the following practices best preserves the objective tone expected in engineering documentation?
- A) Utilizing first-person active narrative to highlight personal breakthrough moments (e.g., "I thoroughly mixed the aggregates...").
 - B) Presenting findings via a clear logical structure while avoiding subjective evaluations and personal prejudices.
 - C) Emphasizing qualitative personal impressions of structural failure over quantitative stress-strain graphics.
 - D) Omitting a literature review to present the experimental framework as entirely unique without historical context.

23. Which section of a technical civil engineering report serves to summarize the research objectives, core methodology, key structural findings, and overarching conclusions within a strict limit of 150-250 words?
- A) Executive Summary
 - B) Abstract
 - C) Introduction
 - D) None of the above
24. A research group in structural engineering submits a paper to a prominent civil engineering journal. The journal has a Journal Impact Factor (JIF) of 4.0 for the year 2026. Which of the following statements correctly interprets this metric?
- A) A paper published in this journal during 2024 and 2025 received an average of 4.0 citations in the year 2026.
 - B) Every individual paper published in this journal during 2026 is guaranteed to receive at least 4 citations within two years.
 - C) The journal has published a total of 400 high-impact civil engineering papers over the last decade.
 - D) The citation counts for the journal's articles follow a perfectly normal distribution with a mean value of 4.0.
25. A civil engineering researcher invents a novel, cost-effective geopolymers concrete mix using a unique blend of industrial waste materials. The researcher publishes the comprehensive chemical composition, performance parameters, and production process in a reputed peer-reviewed journal. Six months later, they apply for a patent in India. Which of the following statements is true regarding this scenario under Indian IPR laws?

- A) The researcher will be granted a patent because they are the original inventor and the disclosure was in an academic journal.
 - B) The patent application will likely be rejected because the prior publication destroyed the mandatory "novelty" requirement.
 - C) The researcher will only be granted a copyright for the concrete mix formulation instead of a patent.
 - D) The patent will be granted automatically with a shortened validity period of 10 years.
26. Which of the following statements perfectly describes the phenomenon of the "angle of repose" for a granular material resting on an inclined plane?
- A) It is the maximum angle of the incline at which a body will begin to slide up the plane due to a horizontal force.
 - B) It is the angle of the incline at which the body is in impending motion down the plane purely under its own weight.
 - C) It is always strictly greater than the static angle of friction for any given pair of contact surfaces.
 - D) It represents the orientation where the normal reaction force completely balances the frictional force.
27. According to D'Alembert's principle, a dynamic system can be transformed into an equivalent static equilibrium system by introducing an imaginary "inertia force". What is the correct magnitude and direction of this inertia force?

- A) Equal to the product of mass and acceleration, acting in the same direction as the acceleration.
 - B) Equal to the net external force, acting perpendicular to the direction of motion.
 - C) Equal to the product of mass and acceleration, acting in the direction opposite to the acceleration.
 - D) Equal to the gravitational force, acting vertically downwards regardless of motion.
28. What is the number of independent equations that must be satisfied for the static equilibrium of a planar (2D) rigid structure?
- A) 2
 - B) 3
 - C) 4
 - D) 6
29. In the displacement method (stiffness method) of structural analysis, what are the primary or basic. unknowns determined first?
- A) Displacements
 - B) Forces
 - C) Displacements and forces
 - D) Stresses
30. The radius of Mohr's circle for a two-dimensional state of stress represents which of the following mechanical values?
- A) The maximum principal stress
 - B) The maximum shear stress
 - C) The average normal stress
 - D) The minimum principal stress
31. According to Castigliano's First Theorem, the first partial derivative of the total strain energy of a linearly elastic structure with respect to a given displacement yields which of the following?

- A) The slope at that point
 - B) The deflection at that point
 - C) The external force acting at that point in the direction of the displacement
 - D) The internal bending moment at that section
32. In the limit state design of concrete structures, the strain distribution across any transverse section is assumed to be:
- A) Linear
 - B) Parabolic
 - C) Parabolic and rectangular
 - D) Hyperbolic
33. Which steel section is most efficient and commonly used as a beam to resist bending moments?
- A) Angle section
 - B) Channel section
 - C) I-section.
 - D) T-section
34. The structural property of steel that allows it to undergo significant plastic deformation before fracture is known as:
- A) Elasticity
 - B) Ductility
 - C) Brittleness
 - D) Hardness

35. Which of the following statements accurately characterizes the microstructural nature of the Interfacial Transition Zone (ITZ) in conventional concrete?
- A) The ITZ has a significantly lower porosity and a higher density of C-S-H gel due to the wall effect concentrating fine cement particles.
 - B) The ITZ contains primarily unhydrated silica and exhibits zero porosity due to active pozzolanic reactions at the aggregate boundary.
 - C) The ITZ exhibits higher local porosity, a higher concentration of oriented calcium hydroxide crystals, and larger capillary voids compared to the bulk paste.
 - D) The ITZ is structurally and chemically identical to the bulk cement paste because hydration products grow uniformly from the aggregate outward without restriction.
36. Regarding the fundamental mechanisms responsible for basic creep in hardened cement paste under a sustained compressive load, which of the following phenomena is primarily considered the governing factor?
- A) The chemical breakdown and decalcification of unhydrated cement clinker phases due to continuous micro-cracking over time.
 - B) The sliding of calcium-silicate-hydrate (C-S-II) sheets and the movement or redistribution of adsorbed and interlayer water within the gel pores.
 - C) The permanent evaporation of bulk capillary water into the external atmosphere independent of the internal gel structure.
 - D) The progressive thermal expansion of aggregate particles induced by the environmental temperature variations alone.

37. In a post-tensioned prestressed concrete beam, which of the following losses of prestress does not occur after the tensioning process is completed and the tendons are anchored?
- A) Loss due to friction
 - B) Loss due to creep of concrete
 - C) Loss due to relaxation of steel
 - D) Loss due to shrinkage of concrete
38. During a rapid drawdown condition in an upstream slope of an earthen dam constructed with fine-grained soil, what happens to the stability of the slope, and how do the total stress, pore water pressure, and effective stress change at a point within the slope?
- A) Total stress decreases, pore water pressure increases, effective stress decreases, and stability improves.
 - B) Total stress decreases, pore water pressure decreases instantly to zero, effective stress increases, and stability remains unchanged.
 - C) Total stress decreases, pore water pressure remains temporarily high (does not dissipate immediately), effective stress decreases significantly, and stability is critical.
 - D) Total stress increases, pore water pressure decreases, effective stress increases, and stability is critical.
39. Two identical clay samples are compacted to the same dry density-one on the dry side of optimum moisture content (OMC) and the other on the wet side of optimum. Which of the following statements correctly describes their engineering behavior under loading?

- A) The sample compacted on the dry side exhibits a dispersed structure, lower swelling potential, and lower initial permeability compared to the wet-side sample.
 - B) The sample compacted on the dry side exhibits a flocculated structure, higher strength at low strains, but higher swelling potential when exposed to water.
 - C) The sample compacted on the wet side exhibits a flocculated structure, higher compressibility under high loads, and higher initial strength.
 - D) Both samples behave identically because they are compacted to the exact same dry density.
40. Under which of the following conditions does negative skin friction develop in a pile foundation?
- A) When the surrounding soil settles more than the pile.
 - B) When the pile settles more than the surrounding soil.
 - C) When a heavy static working load is applied directly at the pile head.
 - D) When there is a sudden and drastic drop in the groundwater table level.
41. If the temperature of both a liquid and a gas is increased, how do their dynamic viscosities change, and what is the primary molecular cause for each?
- A) Liquid viscosity increases due to increased molecular momentum transfer; gas viscosity decreases due to decreased cohesive forces.
 - B) Liquid viscosity decreases due to increased molecular momentum transfer; gas viscosity increases due to decreased cohesive forces.
 - C) Liquid viscosity decreases due to a reduction in cohesive forces; gas viscosity increases due to an increase in molecular momentum transfer.
 - D) Both liquid and gas viscosities increase because molecular activity increases with temperature.

45. Why is a properly graded inverse filter (such as a chimney drain and horizontal blanket) provided on the downstream side of an earthen dam rather than allowing seepage water to exit freely across the entire downstream face?
- A) To completely stop all seepage flow through the dam body and maintain a completely dry downstream shell.
 - B) To increase the total seepage head and artificially accelerate the exit velocity away from the core zone.
 - C) To prevent piping and internal erosion by restraining fine base soil particles while allowing free drainage of water.
 - D) To convert turbulent seepage flow into laminar flow, thereby reducing total hydrostatic uplift pressure to zero.
46. Which of the following transport models is primarily used in urban infrastructure planning to predict the future distribution of trips between different zones based on spatial separation and zone attractiveness?
- A) Logit Model
 - B) Gravity Model
 - C) Growth Factor Method
 - D) Intervening Opportunity Model
47. In a typical flexible pavement structure, which layer is primarily responsible for bearing a major portion of the vertical traffic load transmitted from the surface course and spreading it effectively to the lower layers?
- A) Subgrade
 - B) Base course
 - C) Prime coat
 - D) Seal coat

48. How does the fundamental mechanism of load distribution and transfer differ between rigid pavements and flexible pavements?
- A) Rigid pavements transfer loads exclusively through grain-to-grain contact of unbounded aggregates, whereas flexible pavements use high flexural slab bending.
 - B) Both pavement types transfer loads strictly through localized shear failure in the top surface layer without involving the underlying layers.
 - C) Rigid pavements distribute loads via high flexural strength (slab action) over a large area of the subgrade, whereas flexible pavements distribute loads through grain-to-grain transfer across successive layers of decreasing stiffness.
 - D) Flexible pavements rely on steel dowel bars for load transfer across joints, whereas rigid pavements rely purely on bituminous binder cohesion.
49. Which of the following processes occurs during the regeneration phase of a Zeolite (Base-Exchange) water softening plant?
- A) Calcium and magnesium ions are precipitated out as carbonate sludges.
 - B) Sodium ions in the exhausted medium are replaced by calcium and magnesium ions from a highly concentrated brine solution.
 - C) Calcium and magnesium ions attached to the exhausted medium are displaced and replaced by sodium ions using a brine solution.
 - D) Carbon dioxide gas is liberated by adding lime to the exchange bed.

50. In a conventional anaerobic sludge digestion tank, which group of microorganisms is responsible for converting volatile fatty acids into methane and carbon dioxide gas, and what are their typical environmental sensitivities?

- A) Acid-forming heterotrophs; they are highly resilient to sudden temperature fluctuations.
- B) Methanogenic bacteria; they are strictly anaerobic and highly sensitive to pH drops below 6.5.
- C) Facultative autotrophs; they require high dissolved oxygen concentrations to prevent souring.
- D) Aerobic nitrifiers; they function best at low pH levels under high organic loading rates.



- Rough Work -