

001. In a system with significant harmonic distortion, the "True Power Factor" is defined as the product of the Displacement Power Factor ($\cos\phi_1$) and which other component?
- (A) Distortion Factor
 - ✓(B) Reactive Factor
 - (C) Form Factor
 - (D) Crest Factor
002. In the "Three-part Tariff" (Total Cost = $a + b \times \text{kW} + c \times \text{kWh}$), what does the constant 'a' typically represent?
- (A) Variable operating costs specifically related to fuel and machinery lubrication.
 - (B) Semi-fixed charges representing interest and depreciation on the generation plant.
 - ✓(C) Fixed charges independent of load and energy, such as salaries and land taxes.
 - (D) The fluctuating cost of energy dissipation occurring during power transmission.
003. FPPA is an "uncontrollable" cost because:
- (A) Consumers cannot control the total units they need for basic daily usage.
 - ✓(B) Utilities cannot control market-driven fluctuations in global fuel prices.
 - (C) The government cannot control seasonal weather changes affecting solar/wind yield.
 - (D) Metering infrastructure is fixed and cannot be adjusted by the utility.
004. In a power system, a "Negative Voltage Regulation" value is physically significant because it indicates:
- (A) It signifies a short circuit fault leading to a total voltage collapse at the bus.
 - (B) It indicates the presence of excessive inductive reactance causing a major drop.
 - (C) It shows that the system has exceeded its thermal limits due to high resistance.
 - ✓(D) It indicates the receiving end voltage is higher than the sending end voltage.

005. Which of the following is a disadvantage of TOU for consumers?
- (A) It mandates significant changes in daily habits or operations to avoid high costs.
- (B) It provides increased transparency by showing exactly when energy costs are highest.
- (C) It encourages energy efficiency, potentially reducing the total units consumed.
- (D) It improves grid stability by shifting demand away from critical peak periods.
006. Which transformer classification is characterized by having the middle limb area twice that of the outer limbs?
- (A) Core-type 3-phase transformer
- (B) Shell-type 1-phase transformer
- (C) Berry-type transformer
- (D) Distribution transformer
007. In a Step-Down distribution transformer (11kV/440V), why is the HV winding placed outside the LV winding on the core limb?
- (A) To improve the convective flow of oil for better thermal dissipation.
- (B) Because the HV side naturally requires less insulation than the LV side.
- (C) To simplify the provision of tappings and minimize core-to-winding insulation.
- (D) To reduce the total copper losses by minimizing the mean length of turn.
008. A 100 kVA single-phase transformer has an iron loss of 600 W and a full-load copper loss of 1.5 kW. At what percentage of full load will the transformer achieve its maximum efficiency?
- (A) 92.5%
- (B) 86.6%
- (C) 75%
- (D) 63.25%
- Handwritten notes for Q008: $kVA \sqrt{\frac{P_i}{P_c}}$ and $100 \sqrt{\frac{600}{1500}}$
009. For parallel operation of two 3-phase transformers, which condition must be satisfied for proper load sharing regardless of rating difference?
- (A) Same percentage impedance (%Z) referred to their respective kVA ratings.
- (B) Identical absolute impedance (Ω) values on common voltage base.
- (C) Matching vector group clock hour positions.
- (D) Equal no-load current percentages.

010. In a biased differential relay for transformer protection, the bias slope is set to 20%. During a through fault, CT currents are 10 A and 9 A. What happens?

- (A) Relay trips immediately as differential current exceeds bias threshold.
- (B) Relay does not trip due to bias restraint margin.
- (C) Relay trips due to CT saturation detected.
- (D) Relay blocks due to harmonic restraint activation.

011. In an induction motor, the ratio of "Rotor Copper Loss" to "Rotor Input Power" is equal to:

- (A) $1-s$
- ✓ (B) $1/s$
- (C) s
- (D) s^2

Handwritten calculations for Q11:

$$\frac{1-s}{s} \cdot \frac{s}{1-s} = 1$$

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$$\frac{1-s}{s} \cdot \frac{s}{1-s} = 1$$

012. If the air-gap power of a 3-phase induction motor is 10 kW and the rotor is running at a slip of 4%, the mechanical power developed is:

- (A) 9.0 kW
- (B) 10 kW
- (C) 10.4 kW
- ✓ (D) 9.6 kW

Handwritten calculation for Q12:

$$10 - 0.04 \cdot 10 = 9.6$$

013. According to IS 325, what is the permissible "Voltage Variation" for which an induction motor must be capable of delivering its rated output (though performance may not be optimal)?

- (A) $\pm 2\%$
- ✓ (B) $\pm 5\%$
- (C) $\pm 10\%$
- (D) $\pm 15\%$

014. In Energy Efficient Motors, the "Stray Load Loss" is typically reduced by:

- (A) Increasing the physical air gap to reduce the magnetic coupling, thereby minimizing the formation of parasitic harmonic fluxes.
- ✓ (B) Utilizing specialized stator/rotor slot geometries and improving the surface finish of the laminations to reduce short circuits and harmonic interference.
- (C) Designing the motor with a higher slot-fill factor to enhance the power factor rather than reducing stray fields.
- (D) Reducing the number of magnetic poles to increase the synchronous speed, effectively lowering the relative frequency of the magnetic flux.

015. When performing the Stray Load Loss measurement using the "Indirect Method," why is it necessary to perform the test at different load levels?
- (A) Because stray losses vary with the square of the load current (I^2), requiring a regression analysis of several data points to determine an accurate loss coefficient.
 - (B) To prevent the internal windings from overheating between readings, ensuring that the temperature-sensitive resistance remains constant throughout the entire test duration.
 - (C) Because stray load losses are proportional to the fundamental frequency squared, necessitating measurements at various torque levels to verify that the power supply remains stable.
 - (D) Because stray load losses are directly proportional to the square of the terminal voltage (V^2), meaning different load levels are needed to observe voltage-induced core fluctuations.
016. In a Halogen Lamp, the "Halogen Cycle" prevents the blackening of the glass envelope. For this cycle to function, the wall temperature of the bulb must be at least:
- (A) 100 °C
 - (B) 800 °C
 - (C) 500 °C
 - (D) 250 °C
017. In incandescent lamps, "Gas-filling" (using Argon-Nitrogen mixture) is used instead of a vacuum for lamps above 40W. This is done primarily to:
- (A) To suppress the evaporation of the tungsten filament, which allows the lamp to operate at significantly higher temperatures without a rapid decrease in life.
 - (B) To increase the structural integrity of the quartz or glass envelope, preventing it from imploding under the force of external atmospheric pressure during operation.
 - (C) To introduce a chemical buffer that slows the rate of heat transfer through conduction and convection, thereby forcing the filament to reach its peak resistance faster.
 - (D) To create a pressurized environment that physically constrains the tungsten atoms, enabling the filament to reach higher temperatures for improved luminous efficacy.

018. When an incandescent lamp is first switched on, the initial "inrush" current can be 10 to 15 times the steady-state operating current. This occurs because:
- (A) The inert gas mixture (Argon-Nitrogen) inside the bulb undergoes a brief period of ionization, creating a low-impedance path that allows for a momentary surge of current.
 - (B) The internal inductive reactance of the coiled filament creates a back-EMF that initially opposes the current, causing the supply to provide a higher starting torque.
 - (C) The cold resistance of the tungsten filament at room temperature is significantly lower than its hot resistance at operating temperatures, resulting in a high initial current.
 - (D) The glass envelope of the lamp acts as a temporary capacitor that stores charge, leading to a massive discharge current at the precise moment the electrical circuit is closed.
019. A high CRI (90+) LED and a low CRI (70) LED can both achieve 150 lm/W efficacy. Which is preferred for street lighting applications in residential areas?
- (A) Low CRI LED - Higher blue light content provides better object contrast for traffic
 - (B) High CRI LED - Better colour rendering improves facial recognition and pedestrian safety at night.
 - (C) High CRI LED only for pedestrian zones, low CRI for highways.
 - (D) Both equally suitable as lumen efficacy determines lighting performance.
020. In the design of fluorescent and LED streetlights, there is often an inverse relationship between CRI and Luminous Efficacy. This "Efficacy-CRI trade-off" occurs primarily because:
- (A) To achieve a higher CRI, the lamp's internal electronic driver or ballast must consume additional power to stabilize the complex gas-plasma or multi-channel diode architecture.
 - (B) Increasing the colour quality requires the lamp to operate at lower internal junction temperatures, which reduces the overall quantum efficiency of the light-producing semiconductor materials.
 - (C) The specialized red phosphors required for high CRI have an inherently higher electrical resistance, which causes significant heat dissipation and a direct loss in total radiant efficiency.
 - (D) High CRI requires a broad, continuous spectrum that includes deep red and blue wavelengths; since the human eye is less sensitive to these regions, they provide fewer lumens per watt.

021. Most standard "Cool White" LED streetlights ($R_a \approx 70-80$) exhibit a sharp "blue peak" at approximately 450 nm. If the R_a is increased to 95 using "Sun-Like" LED technology, how does the SPD typically change?
- (A) The dominant 450 nm blue peak is completely removed from the visible spectrum and replaced with a high-intensity ultraviolet (UV) peak to catalyze the phosphor reaction.
 - (B) The sharp blue peak is significantly suppressed, and the "cyan gap" (near 480 nm) and "red tail" (near 630 nm) are filled in to create a smoother, more continuous daylight-like spectrum.
 - (C) The entire spectral distribution is shifted toward the infrared (IR) region, effectively converting the LED into a thermal radiator similar to a high-pressure sodium (HPS) lamp.
 - (D) The light source is filtered until it becomes a monochromatic yellow emitter, intentionally sacrificing colour fidelity to maximize the luminous efficacy of the streetlighting fixture.
022. In some multi-color LED streetlights, the CRI is limited by the "Green Gap." This refers to:
- (A) The physical distance required between individual green LED chips on a circuit board to prevent thermal interference and ensure uniform colour mixing across the fixture.
 - (B) The specific "warm-up" period required for green semiconductor materials to reach their peak luminous flux and stabilize their primary emission wavelength after being energized.
 - (C) The degradation of green phosphors over time.
 - (D) The lack of efficient semiconductor materials that emit light in the 500 nm to 550 nm range, leading to a dip in the spectral power distribution.
023. According to the IES LM-80 standard, LED package manufacturers must test lumen maintenance at a minimum of three specific case temperatures (T_s). Which of the following represents the standard required temperatures?
- (A) 55°C , 85°C , and a third temperature selected by the manufacturer.
 - (B) 25°C , 40°C , and 60°C
 - (C) 0°C , 50°C , and 100°C
 - (D) Only at the maximum rated junction temperature of the chip.

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024. Beyond lumen maintenance (brightness), what other critical parameter is tracked during an LM-80 test that affects the long-term visual quality of streetlighting?

- (A) The physical cracking of the outer glass lens.
- (B) Chromaticity Shift ($\Delta u'v'$), which measures how the colour of the light changes over time.
- (C) The change in the Power Factor of the external driver, which is measured to ensure the electrical efficiency of the entire luminaire remains within utility-mandated limits.
- (D) The surge protection capability of the luminaire, monitored through repeated high-voltage stress tests to confirm the LED's resilience against lightning and grid transients.

025. For the results of an LM-79 test to be valid, the ambient temperature during the entire measurement period must be maintained at:

- (A) $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$
- (B) $50^{\circ}\text{C} \pm 5^{\circ}\text{C}$
- (C) $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- (D) $25^{\circ}\text{C} \pm 1^{\circ}\text{C}$

026. When calculating the Average Illuminance (E_{avg}) using the Nine-Point Method, the centre point (P5) is given a weighting factor of 4. What is the fundamental geometric justification for this weighting?

- (A) To account for the overlapping luminous flux from four adjacent poles at the centre.
- (B) To compensate for the fact that the centre is always the darkest spot between two poles.
- (C) To account for the fact that the centre point represents a full unit area (four quadrants meeting), while corner points represent only one-quarter of a unit area.
- (D) Because the centre point is measured four times to ensure accuracy.

027. When performing field measurements using the Nine-Point Method, the Lux meter sensor must be placed at which specific physical height?

- (A) 1.5 meters above the ground (pedestrian eye level).
- (B) On the horizontal road surface (ground level).
- (C) Exactly 0.75 meters (headlight level).
- (D) At the centre of the pole height.

028. According to IS 1944, why is the Nine-Point Method preferred over taking a single reading under the lamp?
- (A) Because a single reading under the lamp represents the maximum value and ignores dangerous "dark spots" or "zebra effects" between poles.
 - (B) It is required to calculate the electricity bill of the municipality.
 - (C) A single reading is affected by the height of the person being measured.
 - (D) The Nine-Point Method is the only way to measure the CRI of the lamp.
029. According to IS 1944 standards, Group B2 roads (residential roads with light traffic) require what minimum average illuminance level?
- (A) 10 Lux
 - (B) 4 Lux
 - (C) 8 Lux
 - (D) 30 Lux
030. As per IS 1944 (Part 1 & 2), for a road classified as Group B1 (Main roads with medium traffic), what is the maximum recommended Spacing to Mounting Height (S/H) Ratio to ensure acceptable uniformity?
- (A) 1:1
 - (B) 8:1
 - (C) 3:1
 - (D) 12:1
031. If the calculated Overall Uniformity Ratio (U_o) of a newly installed street lighting system is 0.25 on a National Highway (Group A1), the system is considered:
- (A) Invalid, as uniformity cannot be less than 0.5.
 - (B) Superior, as it exceeds the 0.2 standard.
 - (C) Perfect, as 0.25 is the ideal ratio for energy saving.
 - (D) Sub-standard, as it falls below the 0.4 standard.
032. Which parameter, if increased, will generally improve the "Overall Uniformity Ratio" (U_o) of a street lighting installation while keeping the mounting height constant?
- (A) Spacing between poles
 - (B) Luminaire distribution width (Beam Angle)
 - (C) Road width
 - (D) Lumen output of the lamp

033. During a post-installation audit, a City Engineer finds that the lux level at the "Mid-point" between two poles is significantly lower than the minimum required lux (Emin). Which mechanical adjustment to the luminaire is most effective in correcting this Uniformity Gap without replacing the lamp?
- (A) Increasing the tilt (inclination) angle of the luminaire
 - (B) Reducing the mounting height of the pole
 - (C) Painting the pole with reflective silver paint
 - (D) Reducing the overhang distance
034. When transitioning a city's streetlights from High-Pressure Sodium (HPSV) to LED, a City Engineer notes a significant increase in System Efficacy. According to Indian Standards, what specific components must be included in the power calculation to determine the "Luminous Efficacy of the Luminaire" (lm/W)?
- (A) Only the nominal wattage consumed by the LED chips (Source Power), as the driver is considered an external electrical auxiliary, not part of the light-producing semiconductor.
 - (B) The wattage of the LED chips combined with the power loss in the driver, but excluding the power used by any internal cooling fans or thermal management sensors.
 - (C) The total system wattage encompasses the power consumed by the LED chips plus the inherent power losses and "overhead" energy dissipated by the driver or ballast.
 - (D) The total active power (Watts) and reactive power (VAR) consumed by the entire streetlight circuit, including the voltage drop across the secondary distribution cables.
035. For smart street lighting systems, how does the luminous efficacy of an LED luminaire typically behave when it is dimmed to 50% of its rated current, and why is this phenomenon significant for a City Engineer's energy audit?
- (A) The efficacy remains perfectly constant, meaning a 50% reduction in electrical current results in exactly a 50% reduction in both power consumption and light output.
 - (B) The efficacy decreases significantly because the internal resistance of the LED driver increases at lower loads, causing more energy to be dissipated as waste heat.
 - (C) The efficacy drops to nearly zero at 50% power, as LEDs require a specific "threshold current" to maintain the semiconductor's electron-hole recombination process..
 - (D) The efficacy typically increases (reverse 'efficiency droop'), as operating at lower current densities reduces non-radiative losses like Auger recombination and allows the LED to run cooler.

036. In Indian municipal standards, an "Integrated Solar LED Streetlight" is categorized by its luminaire housing. What is the primary technical requirement for the luminaire's "Ingress Protection" (IP) rating to ensure reliability against heavy monsoon rains in India?
- (A) IP20
 - (B) IP44
 - ✓ (C) IP65 or IP66
 - (D) IP80
037. For a City Engineer designing lighting for an Urban Flyover with narrow medians where pole installation is structurally restricted, which specialized luminaire type does the NLC/IS 1944 suggest for "Parapet Lighting" to provide guidance without high-angle glare?
- ✓ (A) Low-mounted Linear LED Luminaires (Handrail Lighting) integrated directly into the parapet wall, utilizing asymmetric optics to distribute light across the carriage-way while keeping the source below the driver's eye level.
 - (B) High Mast Floodlights installed at the base of the flyover, which use high-intensity discharge sources to project light upward, often creating significant glare for drivers at the crest of the bridge.
 - (C) Non-Cut-off Post-top lanterns placed on short decorative pillars, which provide omnidirectional light but fail to meet the strict "threshold increment" (TI) requirements for high-speed urban transit.
 - (D) High-pressure Mercury Vapor lamps mounted on bracket arms, a legacy technology that lacks the precise optical control needed to prevent light spill into the surrounding urban residential areas.
038. In the context of the NLC, how does the "Utilization Factor" (UF) of a luminaire directly relate to energy saving in a new street lighting project?
- (A) A lower UF is preferred in residential areas as it provides "spill light" to illuminate sidewalks, effectively increasing the system's total area coverage.
 - ✓ (B) A higher UF represents superior colour rendering accuracy, which improves nighttime visibility without changing the system's power consumption.
 - (C) UF measures the rate of lamp lumen depreciation, where a high value reduces the need for frequent cleaning and physical maintenance.
 - (D) A higher UF allows the use of lower-wattage lamps by ensuring more of the generated light reaches the intended road surface.

039. In the context of Energy Management, a City Engineer must ensure that LED control gears comply with IS 16104 regarding Standby Power Consumption. According to the NLC, what is the maximum recommended power that a "Smart" LED driver or control node should consume when the lamp is in the "OFF" state but the communication remains active?
- (A) 0.0 Watts
 - (B) 5.0 Watts
 - (C) Less than 0.5 Watts per node
 - (D) 10% of the rated lamp wattage
040. In "Park and Garden Lighting" (Group E subset), the application of "Moonlighting" involves placing luminaires high in trees and directing light downwards. What is the primary design goal of this application?
- (A) To provide high-intensity horizontal lux required for high-definition facial recognition and CCTV surveillance.
 - (B) To create a naturalistic, soft light and shadow pattern on the ground by filtering light through tree canopies.
 - (C) To utilize specific ultraviolet wavelengths to attract and eliminate insects that damage sensitive tree species.
 - (D) To project light toward the sky to increase nighttime visibility for local aviation and helicopter landing zones.
041. Which form of "Hydro-Kinetic" energy is classified as renewable and utilizes the kinetic energy of flowing water in rivers or man-made channels without the need for large dams or reservoirs?
- (A) Run-of-River (RoR) Hydroelectric Systems
 - (B) Pumped Storage Hydropower
 - (C) Impoundment Hydropower
 - (D) Atmospheric Water Generation
042. What is the primary advantage of the "Renewable Purchase Obligation" (RPO) for the growth of the green energy market in India?
- (A) It mandates that renewable energy producers purchase coal-based power to balance grid frequency during peak hours.
 - (B) It grants the government legal authority to acquire and nationalize private solar farms to meet national climate goals.
 - (C) It provides free land and tax-free infrastructure for any citizen or company installing a rooftop solar panel system.
 - (D) It creates a guaranteed market demand by mandating that DISCOMS and large consumers purchase a minimum percentage of green electricity.

043. What is the "Technical Advantage" of using "Micro-Hydro" systems (below 100 kW) in hilly terrains compared to long-distance grid extension?
- (A) Micro-hydro systems utilize "fit-and-forget" technology that requires zero maintenance or desilting over their thirty-year operational lifespan.
 - (B) They offer a decentralized solution that eliminates the massive Transmission and Distribution (T&D) losses and high infrastructure costs of mountain grid lines.
 - (C) They utilize advanced atmospheric condensers to continue generating full rated power even when the local stream completely dries up during summer.
 - (D) They generate a specialized form of low-frequency electricity that is inherently safer for domestic use than the standard grid-supplied AC power.
044. In "Bifacial" solar module technology, what is the primary source of the energy generated by the rear side of the panel?
- (A) Direct ultraviolet radiation that penetrates through the silicon layers, allowing the rear side to capture high-energy photons that were missed by the front surface.
 - (B) Magnetic induction generated by the interaction between the aluminium mounting structure and the earth's magnetic field during peak daylight hours.
 - (C) Albedo (reflected light from the ground or surface), where the rear side captures sunlight bounced off the mounting area, significantly increasing the total energy output.
 - (D) Thermal infrared radiation absorbed from the surrounding atmosphere, which converts the heat generated by the module's operation back into electrical energy.
045. What is the fundamental purpose of a Maximum Power Point Tracker (MPPT) in a solar charge controller or inverter?
- (A) To continuously adjust the electrical operating point of the modules to ensure they deliver maximum available power to the load or battery.
 - (B) To control the mechanical motor drives that physically tilt the solar panels to follow the sun's trajectory across the sky.
 - (C) To act as a rectifier that converts incoming AC power from the national grid into DC power to charge the solar modules.
 - (D) To serve as a safety shut-off valve that limits the input voltage to prevent the battery from overheating or exploding.

046. In a Remote Monitoring System (RMS) for a large-scale solar farm, what is the primary role of an "SCADA" system?
- (A) To act as a mechanical automation tool that physically cleans dust and debris from the surface of solar panels at scheduled intervals.
 - (B) To collect, visualize, and analyze real-time data from inverters, weather stations, and meters for performance tracking and fault detection.
 - (C) To provide a comprehensive physical security layer through biometric access control and motion-detecting infrared cameras around the farm perimeter.
 - (D) To modify the internal chemical composition of the silicon cells to increase their innate photovoltaic conversion efficiency during high-temperature periods.
047. In a solar thermal power plant (CSP), what is used to collect and concentrate sunlight to produce high-temperature steam?
- (A) Photovoltaic Wafers
 - (B) Lead-acid Batteries
 - (C) Aluminium Fin Heat Sinks
 - (D) Mirrors or Lenses (Heliostats)
048. What does the term "PERC" stand for in modern high-efficiency solar module technology, and what is its primary technical function?
- (A) Photo-Electric Radiant Cell, which uses a specialized gas-filled chamber to amplify photon energy before it hits the silicon wafer.
 - (B) Polycrystalline Energy Recovery Circuit, an external wiring system designed to capture and reuse electrical leakage from the edges of the panel.
 - (C) Passivated Emitter and Rear Cell, which adds a dielectric layer to reflect unabsorbed light back into the cell for a second chance at conversion.
 - (D) Parabolic Energy Reflection Coating, a microscopic lens-like surface treatment that concentrates light onto the center of each individual cell.
049. Which IEEE standard defines the technical requirements for the interconnection of distributed resources with electric power systems, including the mandate for anti-islanding? Easy
- (A) IEEE 1547
 - (B) IEEE 1284
 - (C) IEEE 802.11
 - (D) IEEE 1394

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050. The "Incremental Conductance" method for MPPT is based on the fact that the derivative of the power with respect to voltage (dP/dV) is zero at which point?
- (A) The open-circuit voltage point (V_{oc}) where the current flow is zero and no power is delivered.
 - (B) The short-circuit current point (I_{sc}), where the voltage is zero and the panel generates maximum heat but zero power.
 - (C) The point of minimum efficiency typically occurs during extreme shading or high-temperature saturation.
 - (D) The maximum power point (MPP) where the product of current and voltage reaches its peak value.
051. Which technical definition precisely describes the "Capacity Utilization Factor" (CUF) of a solar power plant as per standard Indian engineering practices?
- (A) The ratio of the annual peak power output to the total theoretical energy potential under ideal laboratory test conditions.
 - (B) The ratio of the net energy delivered to the grid to the total solar radiation incident on the active surface of the modules.
 - (C) The ratio of the actual annual energy generated to the energy produced if the plant operated at full capacity 24 hours a day.
 - (D) The ratio of the total operational hours of the inverter to the total number of hours available in a standard calendar year.
052. What is the specific role of the "State Load Despatch Centre" (SLDC) in the banking process for large-scale solar projects?
- (A) To perform the physical maintenance and routine cleaning of the solar modules to ensure daily generation targets.
 - (B) To provide the primary financial funding and low-interest loans for the procurement of advanced inverter technology.
 - (C) To regulate the physical operating temperature and thermal expansion of the high-voltage transmission line conductors.
 - (D) To maintain the official scheduling, monitoring, and energy accounting of injection and drawl for final settlement.
053. What is the primary technical characteristic of a Doubly Fed Induction Generator (DFIG) used in modern wind turbine systems?
- (A) It allows the turbine to operate at constant speeds while maintaining a variable frequency to the grid.
 - (B) It allows the turbine to operate at variable speeds while maintaining a constant frequency to the grid.
 - (C) It allows the turbine to operate without any power converters while maintaining a high reactive output.
 - (D) It allows the turbine to operate with a direct-drive mechanism while maintaining a low rotational torque.

054. Why are Vertical Axis Wind Turbines (VAWT) less commonly used for large-scale utility power generation compared to Horizontal Axis (HAWT)?
- (A) Because they generally require much higher wind speeds to initiate the rotation process.
 - (B) Because they generally occupy significantly more ground space for the same power rating.
 - (C) Because they generally cannot be integrated with standard three-phase power inverters.
 - (D) Because they generally exhibit lower aerodynamic efficiency and face higher fatigue loads.
055. In a DFIG wind turbine, which component handles the power flow between the rotor and the utility grid?
- (A) A partial-scale bidirectional power converter connected to the rotor winding circuit.
 - (B) A full-scale unidirectional power converter connected to the stator winding circuit.
 - (C) A high-speed mechanical clutch connected to the main shaft and the generator unit.
 - (D) A liquid-cooled resistor bank connected to the external braking and safety circuit.
056. Which specific role does the National Institute of Wind Energy (NIWE) play in the "Wind Resource Assessment" phase for a private developer in India?
- (A) Providing a legal guarantee that the wind speeds at the site will remain constant for the entire duration of the PPA.
 - (B) Providing the physical labour and machinery required to excavate the foundations for the wind monitoring masts.
 - (C) Providing high-resolution data from its network of wind monitoring stations to validate the site's generation potential.
 - (D) Providing the insurance coverage for the wind turbines against damage caused by extreme lightning or cyclonic storms.
057. In the context of the 'National Green Hydrogen Mission', what is the main technical hurdle for 'Hydrogen Blending' in existing City Gas Distribution (CGD) networks?
- (A) The chemical reaction between hydrogen and methane that produces heavy liquid hydrocarbons in the pipes.
 - (B) The risk of hydrogen embrittlement in older steel pipelines and the higher leakage rate through seals.
 - (C) The inability of hydrogen to burn in standard household stoves that are calibrated for natural gas.
 - (D) The significant increase in the weight of the gas mixture which leads to the collapse of overhead supports.

058. Why is the storage of hydrogen in Salt Caverns being explored in India as a superior alternative to pressurized surface tanks for large-scale energy storage?
- (A) The salt reacts with hydrogen to create a non-flammable solid compound that is easier to transport.
 - (B) They eliminate the need for any compression because the natural earth pressure liquefies the hydrogen.
 - (C) They naturally convert gaseous hydrogen into liquid ammonia through the salt's catalytic properties.
 - (D) They provide massive storage volumes with very low leakage rates and can handle high-pressure fluctuations.
059. What is the primary technical limitation of transporting hydrogen in a Liquefied State (LH₂) via tanker trucks in hot climates like India?
- (A) The risk of the hydrogen freezing into a solid block and blocking the outlet.
 - (B) The chemical reaction between liquid hydrogen and the nitrogen in the truck tyres.
 - (C) High energy loss due to continuous boil-off caused by ambient heat gain.
 - (D) The significant increase in the weight of the liquid which exceeds road bridge limits.
060. Which process uses solar energy directly to split water into hydrogen and oxygen using semiconductor materials without an intermediate electricity generation step?
- (A) Photoelectrochemical (PEC) water splitting using specialized photo-electrodes.
 - (B) Solar Photovoltaic (PV) cells connected to a separate alkaline electrolyzer.
 - (C) Solar Thermal Steam Reforming utilizing concentrated solar heat and methane.
 - (D) Concentrated Solar Power (CSP) used to drive a conventional steam turbine.
061. The correct sequence of the centrifugal pump components through which the fluid flows is
- (A) Impeller, suction pipe, foot valve and strainer, delivery pipe
 - (B) Foot valve and strainer, suction pipe, Impeller, delivery pipe
 - (C) Impeller, suction pipe, delivery pipe, foot valve and strainer
 - (D) Suction pipe, delivery pipe, Impeller, foot valve and strainer

062. Select the pump for high head and high discharge requirements
 (A) Positive displacement pump
 (B) Single stage centrifugal pump
 ✓ (C) Multi stage centrifugal pump
 (D) Jet pump
063. A centrifugal pump needs 1000 W of power when operating at 1500 rpm. What is the power requirement if the speed of the pump is increased to 4500 rpm?
 (A) 6.5 kW
 ✓ (C) 30 kW
 (B) 27 kW
 (D) 20 kW
064. A centrifugal pump gives maximum efficiency when its blades are
 (A) Bent backward
 (C) Straight
 (B) Bent forward
 ✓ (D) Wave shaped
065. Which one of the pumps is not a positive displacement pump?
 (A) Reciprocating pump
 ✓ (B) Centrifugal pump
 (C) Vane pump
 (D) Lobe pump
066. Which of the efficiency mainly takes into the account the losses due to leakage in pumps?
 (A) Manometric efficiency
 (B) Overall efficiency
 ✓ (C) Mechanical efficiency
 (D) Volumetric efficiency
067. What is the result of adding the centrifugal pumps in parallel?
 (A) Discharge increases
 (B) Head increases
 ✓ (C) Both head and discharge increase
 (D) Head and discharge remain constant
068. Which of the following centrifugal pumps can be effectively used for pumping sewage water?
 (A) Close impeller type centrifugal pump
 ✓ (B) Semi open impeller type centrifugal pump
 (C) Open impeller centrifugal pump
 (D) All of the above

$$P \propto N^3$$

$$\frac{1000}{1500} = \frac{P}{4500^3}$$

$$P = \frac{1000 \times 4500^3}{1500^3}$$

$$P = 1000 \times \left(\frac{4500}{1500}\right)^3$$

$$P = 1000 \times 27$$

$$P = 27000 \text{ W} = 27 \text{ kW}$$

069. The diameters at the inlet and outlet of the impeller of a centrifugal pump are 200 mm and 400 mm respectively. Determine the minimum speed required to raise water to the height of 25 m assuming 100% hydraulic efficiency.
- (A) 1221 rpm (B) 1350 rpm
(C) 1471 rpm (D) 1100 rpm
- 200 mm
0.2
070. A centrifugal pump should be installed above the water level in the sump in such a way that
- (A) The negative pressure should not develop in the impeller
(B) The negative pressure do not reach as low as the vapour pressure
(C) Its height is more than 10.3 m
(D) None of the above
- $\omega = \frac{v}{r} = \frac{v}{\frac{D}{2}}$ $\frac{10.3}{\frac{D}{2}}$
071. 1.5 kW per ton of refrigeration is required to maintain the temperature of 233 K for the refrigeration cycle working on the Carnot cycle. COP of the cycle is
- (A) 3.5 (B) 4
(C) 2.33 (D) 2.67
- $COP = \frac{T_c}{T_c - T_h} = \frac{233}{233 - 273}$
072. Dominant mode of heat transfer from very high temperature bodies such as a furnace is
- (A) Radiation (B) Convection
(C) Conduction (D) None of the above
073. Which of the following component is not required in the summer air-conditioning system for hot and dry outdoor conditions
- (A) Air filter (B) Adiabatic humidifier
(C) Resistance heating coil (D) Water eliminators
074. Which of the following is the method of air cleaning?
- (A) Air filtration (B) Air sterilization
(C) Air ionization (D) All of the above
075. Which of the following air conditioning parameters is of utmost importance in textile industries?
- (A) Air quality (B) Temperature
(C) Relative humidity (D) Air circulation
076. The determination of turbidity in water falls under which type of test?
- (A) Physical tests (B) Biological tests
(C) Chemical tests (D) Radiological tests

077. Which statement is NOT true in case of turbidity?
- (A) The character and amount of turbidity depend on the type of soil over which water has moved
 - (B) Ground waters are generally more turbid than the surface water
 - (C) The turbidity is commonly determined by turbidity rod or tape
 - (D) In Jackson's turbidity meter, standard candle or bulb is used as light source

078. Which option shows correct match for the various processes of water treatment plant?

- | | |
|--|--|
| 2(A) Floating matter such as leaves etc. | 1. Sedimentation with coagulation |
| (B) Fine suspended matter | 2. Screening |
| (C) Micro-organism and colloidal matter | 3. Disinfection |
| 3 (D) Pathogenic bacteria | 4. Filtration |
| (A) A-1, B-2, C-3, D-4 | <input checked="" type="checkbox"/> (B) A-2, B-1, C-3, D-4 |
| (C) A-1, B-2, C-4, D-3 | <input checked="" type="checkbox"/> (D) A-2, B-1, C-4, D-3 |

079. If L is length of settling zone
 H is depth of water in settling zone
 V is horizontal velocity of flow of water
 V_s is setting velocity of particle
 Which is the correct relation for the condition of a particle to move into sludge zone for removal?
- (A) $L/V_s > H/V$
 - (B) $L/V > H/V_s$
 - (C) $L/V_s < H/V$
 - (D) $L/V < H/V_s$

080. Which of the following is correct sequence of water treatment plant?
- (A) Screen-Sedimentation Tank-Flocculation basin-Rapid sand filter-Chlorinator
 - (B) Screen-Flocculation basin- Sedimentation Tank-Rapid sand filter-Chlorinator
 - (C) Screen-Flocculation basin- Sedimentation Tank-Chlorinator-Rapid sand filter
 - (D) Screen- Sedimentation Tank- Flocculation basin-Chlorinator-Rapid sand filter

081. The distribution system suitable for towns having rectangular layout of road is
- (A) Tree system
 - (B) Dead end System
 - (C) Grid-iron system
 - (D) Radial System
- 



082. Which of the following method is used to design the water distribution networks
(A) Hardy-Cross method (B) Moody's method
(C) Versanate method (D) Bazin's method
083. Which of the following is used for determining the capacity of storage reservoir?
(A) Mass curve (B) Double mass curve
(C) Isohyet curve (D) Isobar
084. When chlorine is added to water, which of the following is free available chlorine?
(A) Cl_2 (B) HOCL only
(C) OCL only (D) HOCL and OCL
085. Which of the following is not true statement regarding treatment of water?
(A) The process of killing all types of bacteria from water is called sterilization
(B) The process of killing the pathogenic bacteria from water is called disinfection
(C) The most common disinfectant used for dug well water, pond water is potassium permanganate
(D) pH value and temperature of water do not affect chlorine demand for treating a sample of water
086. Match the correct types of treatment units employed in sewage treatment with their function from the below given table
- | | |
|--|-----------------------------|
| (A) Removal of floating materials like tree branches etc | 1. Skimming tank |
| (B) Removal of fats and grease | 2. Screen |
| (C) Removal of pathogens and very fine organic matter | 3. Chlorinator |
| (D) Removal of fine suspended and dissolved organic matter | 4. Activated sludge process |
- (A) A-1, B-2, C-3, D-4 (B) A-2, B-1, C-3, D-4
(C) A-2, B-1, C-4, D-3 (D) A-1, B-2, C-4, D-3
087. Which of the following works on the principle of anaerobic digestion
(A) Septic tank (B) Oxidation pond
(C) Trickling filter (D) Activated sludge process

088. Which of the following is NOT true in the case of solids present in the sewage?
- (A) The total amount of solids present in the sewage can be determined by evaporating a sample of sewage and weighing the dry residue left.
 - (B) Sewage contains 0.1 to 0.5 percent of total solids
 - (C) Sewage contains suspended solids, dissolved solids, colloidal solids and settleable solids
 - (D) Solids in the sewage comprises of both organic and inorganic solids
089. In general, nature of fresh sewage and stale sewage respectively is
- (A) Alkaline and Acidic
 - (B) Acidic and Alkaline
 - (C) Acidic and Neutral
 - (D) Alkaline and Neutral
090. Which of the following is not true in the case of BOD of waste water?
- (A) The rate at which BOD is satisfied at any time depends on temperature and nature of organic matter present in sewage at that time
 - (B) The first demand of oxygen due to oxidation of organic matter is known as carbonaceous demand
 - (C) The latter demand of oxygen due to biological oxidation of ammonia is called nitrogenous demand
 - (D) Sewage having 5-day BOD around 200ppm is called strong sewage
091. The test carried out on sewage to determine the extent of readily oxidisable organic matter present in the sewage is
- (A) BOD
 - (B) COD
 - (C) DO
 - (D) Total solids
092. The main purpose of secondary treatment in a sewage treatment plant is to remove
- (A) Dissolved and colloidal organic matter
 - (B) Settleable solids
 - (C) Inorganic solids
 - (D) Floating matter
093. Which of the following component a typical sewage pumping station does NOT have?
- (A) Coarse and fine screens
 - (B) Grit channel
 - (C) Rising main
 - (D) Flocculation chamber

094. The process used to reduce the moisture content of sludge before its final disposal is called
- (A) Sludge thickening
(B) Sludge drying
(C) Sludge dewatering
(D) Sludge removal
095. In an activated sludge process, the Sludge Volume Index (SVI) is used to:
- (A) Measure the organic content of sludge
(B) Determine the settleability of sludge in the secondary clarifier
(C) Calculate the BOD of the effluent
(D) Measure the rate of biological oxidation
096. The ozone layer is generally located between which altitudes above the Earth's surface
- (A) 0-10 km
(B) 10-20 km
(C) 15-40 km
(D) 40-60 km
097. CRCAP (Climate Resilient City Action Plan) proposes how many scenarios for planning?
- (A) 1
(B) 2
(C) 20
(D) 40
098. Cleaner Production primarily focuses on
- (A) Treating pollution after generation
(B) Increasing industrial output
(C) Expanding landfill areas
(D) Preventing pollution at source
099. Which Ocean energy source utilizes the temperature difference between warm surface water and cold deep water.
- (A) Wave energy
(B) Tidal energy
(C) Ocean thermal energy conversion
(D) Salinity gradient energy
100. Biogas mainly contains
- (A) 65% methane & 30% carbon dioxide.
(B) 40% carbon dioxide & 60% Nitrogen oxides.
(C) 45% Sulphur dioxide & 55% carbon dioxide
(D) 85% Sulphur dioxide & 15% methane