



المؤسسة العامة لتحلية المياه المالحة
Saline Water Conversion Corporation (SWCC)

أسئلة مقابلات عن الهندسة الكهربائية (باللغة الإنجليزية)

مشتق البرنامج التدريبي الذي انعقد في
المؤسسة العامة لتحلية المياه المالحة عام
2019.

تم إعدادها الملف من قبل
م. جعفر الحسيني بمساعدة أصدقائه المتدربين
في القسم أثناء التدريب

هذا الملف لقي قبول وثناء
من المهندسين الخرجين والخبرة

Q1: Why do we use transformers?

A1: Transformer main application is to change the level of voltage (and current) while keeping the same power. This is essential for transmission as you can reduce the power losses by stepping up the voltage while maintaining almost the same power.

Q2: What are the types of transformers?

A2:

1- Power Transformers: Used between the generation and the distribution grid.

2- Distribution Transformers: Used at the last phase of the distribution to convert the high grid voltage to the end-user voltage (for example: 220V)

3- Instrument Transformers: Used in various applications for measurement, control, and protection.

Q3: State the types of losses in the transformer?

A3:

1- Copper losses: the losses as a result of the current going through the windings.

2- Core losses: A- Hysteresis losses. B- Eddy current losses.

Q4: Voltage values in distribution transformer?

A4: They step-down voltage from up to 67 KV to the voltage required by the load, for domestic use it steps down the voltage from 13.8 KV to (220V-400V).

Q5: What is over fluxing in the transformer?

A5: Over-fluxing happens when the flux density reaches beyond saturation point which causes excessive heat in the core and increase amount of leakage flux. main causes of over fluxing are higher than normal voltage across the winding and/or low frequency.

Q6*: Explain Hysteresis losses and what causes them and how they can be minimized?

A6: Hysteresis losses occur because of the molecular action inside the core due to the linkage magnetic flux moving inside it. The amount of losses depend on what material the core is made of.

Q7*: Explain Eddy current losses and what causes them, and how can we minimize them?

A7: Because of the magnetic flux inside the core is changing, it creates a circulating current around it. It can be minimized by laminating the core which decreases the amount of current circulating in each segment.

Q8: State the transformer equation?

A8: $a = \frac{n_1}{n_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$ a: turns ratio. n: number of turns. 1: Primary. 2: Secondary.

Q9: What type of protection is used in the transformer?

A9: Mainly:

- 1- Internal faults and oil related faults:** Buchholtz relay and differential protection.
- 2- Saturation or over-fluxing:** Over-fluxing protection.
- 3- Earth faults:** Differential protection and earth fault relay.
- 4- Overloads:** Thermal over-load relay and over-current relay.
- 5- High voltage surges:** Surge arresters.

Q10*: State the types of induction motors?

A10*:

- 1- Three phase:** A- Squirrel cage. B- Wound rotor.
- 2- Single-phase:** A- Split phase. B- Capacitor motor. C- Shaded pole.

Q11: State the types of DC motors:

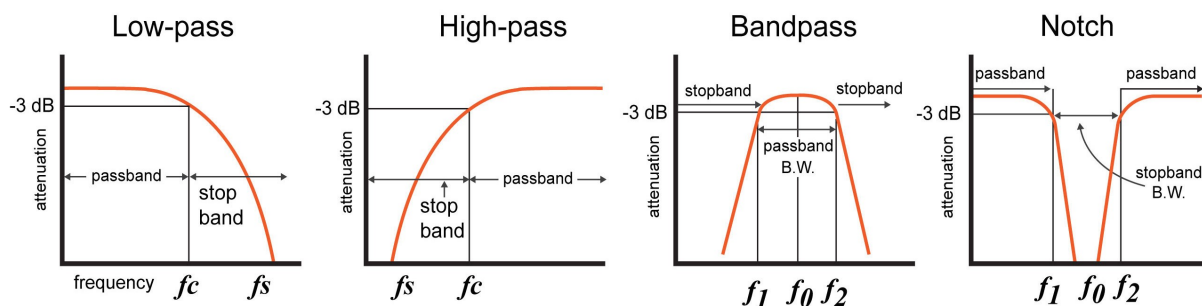
A11: 1- Series DC motor. 2- Shunt DC motor. 3- Compound DC motor.

Q12: What are the windings in a single-phase motor?

A12: stator of a single phase motor has two windings: 1- Main winding and 2- Starting winding (auxiliary winding). These two windings are connected in parallel across a single phase supply and are spaced 90 electrical degrees apart. Phase difference of 90 degree can be achieved by connecting a capacitor in series with the starting winding

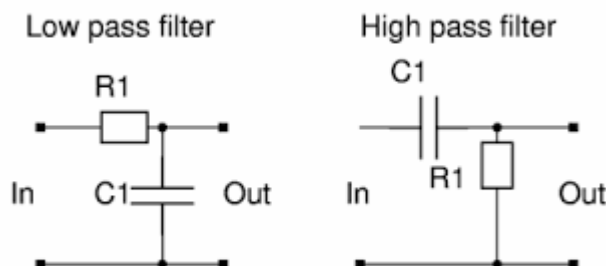
Q13: State the type of filters in communication systems?

A13: 4 types: 1- Low Pass. 2- High pass. 3- Bandpass. 4- Bandreject (Notch).



Q14*: Draw the low-pass and high-pass filters circuits?

A14:



Q15: What is digital signal processing (DSP)?

A15: DSP first converts an analog signal into a digital signal and then applies signal processing techniques and algorithms such as Fourier and Laplace transforms. For example, when performed on audio signals, DSP helps reduce noise and distortion. Some of the applications of DSP include audio signal processing, digital image processing, speech recognition, biomedicine and more.

Q16*: Why Fourier and Laplace transforms are used in signal processing?

A16: They are used to transform the signal to its frequency domain equivalent where it's relatively easier to analyze and manipulate compared to its real time domain representation.

Q17: Explain the work principle of the generator and how it produces electricity?

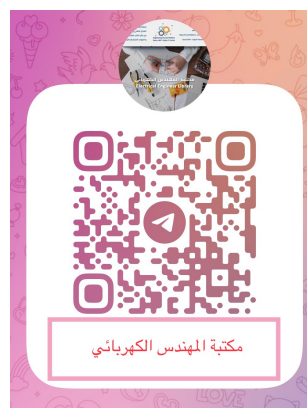
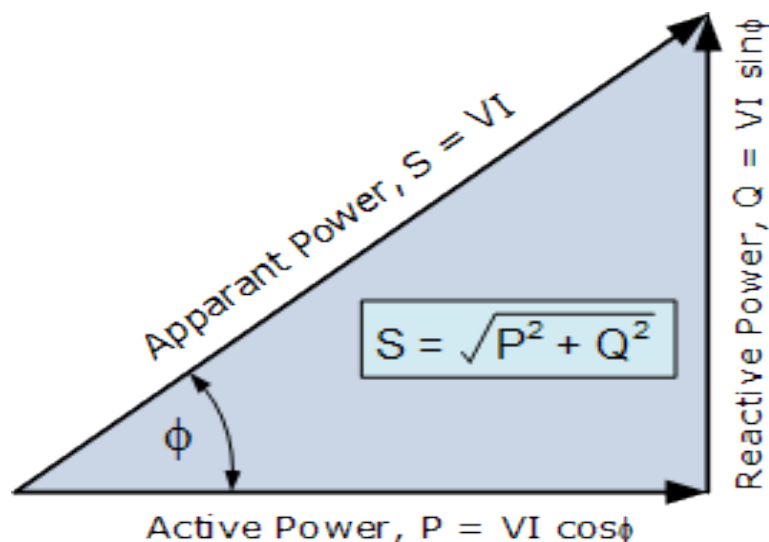
A17: The main working principle of generators and motors is based on **Faraday's Law of induction**:

$$emf = -N \frac{d\phi}{dt}$$

where a voltage is induced either by: **1- applying a changing magnetic field on a conductor** or **2- rotating the conductor around a fixed magnetic field**. In generators the first method is used. In generators we have the field windings (rotor) and the armature windings (stator). The rotor windings are excited by DC supply to generate the magnetic field and then the rotor rotates by the prime mover which results in a rotating magnetic that cuts through the states windings. As a result, AC voltage is produced in the stator windings.

Q18: What are the types of power and what are their respective equations?

A18:



Q19*: What are the types of transformer connections? explain their advantages?

A19: In a transformer these connection types have these advantages:

1- Delta:

A- Eliminates the distortion caused by the third harmonic current from the generator side.

B- $I_{Phase} = \frac{I_{Line}}{\sqrt{3}}$, The line current is divided by root 3 in each phase, allowing for less cross-sectional area in the windings.

2- Star:

A- $V_{Line} = \sqrt{3} V_{phase}$, The line voltage is higher than the phase voltage by a factor of root 3, this is important for transmission as the current is reduced at the line which results in reduced power losses. Additionally, it requires less insulation.

B- Star connection allows for utilizing the neutral as ground, protecting the equipment and personal.

In conclusion, it's common to connect the primary side of the transformer in the generation side as Delta, while connecting the distribution secondary side as star. Between them the connection can vary based on economic and protection studies.

Q20: How can we regulate voltage?

A20: Voltage regulation can be achieved by using transistors, diodes or combination of both with feedback to eliminate the voltage difference between the input and the output.

Q21: How much voltage a generator in the plant produces?

A21: Here in Saudi Arabia the main generators are typically 13.8 KV.

Q22: From where do we get the DC excitation current for the generator?

A22: From an external DC supply, such as a battery.

Q23*: Why DC excitation is used in the generator instead of AC excitation?

A23: If AC excitation is used at the rotor, the produced magnetic field will be alternating in addition of it being rotating. As a result the stator and rmf of the rotor will NOT be magnetically locked and synchronous speed will never be achieved because the poles of this rotating magnetic field will be constantly changing. On the other hand, DC excitation will produce a constant rotating magnetic field cutting through the stator allowing magnetic lock to happen and synchronous speed to be achieved.

Q24: What is the difference between the transformer connected to the generator and the transformer connected to the load and what they are called?

A24:

1-The transformer at the generation side is called a 'Power Transformer'.

- Usually has a rating of above 500 KVA.
- Can transform the voltage from the generation to a voltage of around 400 KV in some applications (in SWCC, to 230 KV)
- Much bigger in size than distribution transformers.

2- The transformer at the generation side is called a 'Distribution Transformer'.

- Usually a rating of 500 KVA and below.
- Can transform voltage from around 67 K and below to the value used by the load (I.e 13.8 KV to 220V or 400V).
- Much smaller in size.

Q25*: What do we mean by harmonics in electrical systems?

A25: The presence of harmonics in electrical systems means that current and voltage are distorted and deviate from sinusoidal waveforms.

Harmonic currents are caused by non-linear loads connected to the distribution system. A load is said to be non-linear when the current it draws does not have the same waveform as the supply voltage. The flow of harmonic currents through system impedances in turn creates voltage harmonics, which distort the supply voltage.

Q26: What do we mean by second or third harmonic?

A26: Any signal has a fundamental frequency 'f' (In Saudi Arabia it's 60 Hz). The second harmonic can be if the signal frequency is doubled ($2f = 120$ Hz) and the third harmonic can be seen if the fundamental frequency is tripled ($3f = 180$ Hz).

Q27: How do we get rid of a noise in a signal?

A27: Filters are the common method used to remove noises. The common filters used are:

1- Median filters. 2- Averaging filters. 3- Gaussian filters.

Q28: What is a UPS system and why it is used?

A28: UPS is a system which provides an uninterrupted power supply when the main power source fails, it provides protection from power interruptions to essential equipment like the control system. It's a combination of rectifiers (to convert AC to DC), smoothing coils (to smooth the rectified dc signal), batteries (to be charged and used when needed), and inverters (to convert DC back to AC).

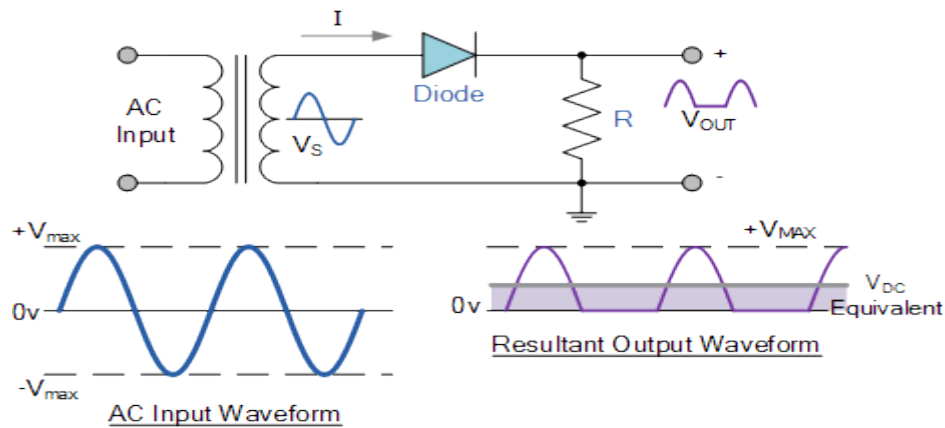
Q29: Where is the UPS in the single line diagram of the power system?

A29: Typically it's between a step down transformer and the plant auxiliary loads.

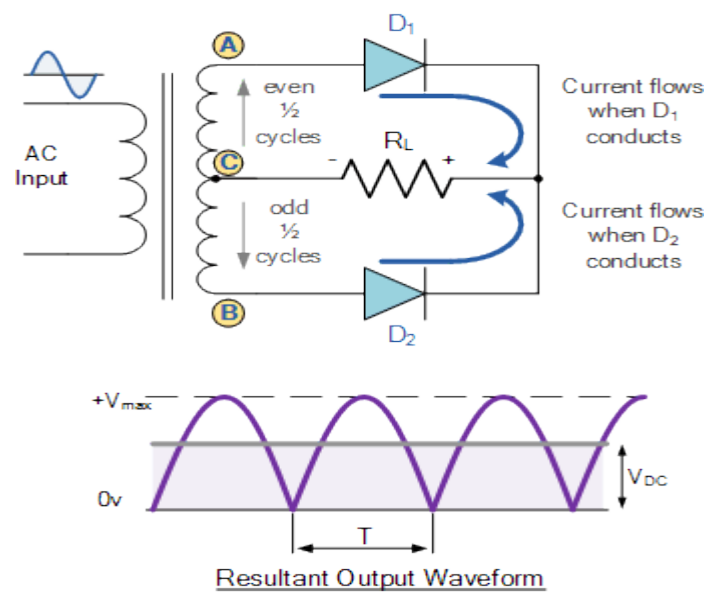
Q30: What are the types of rectifiers and draw their circuits and the output wave form?

A30:

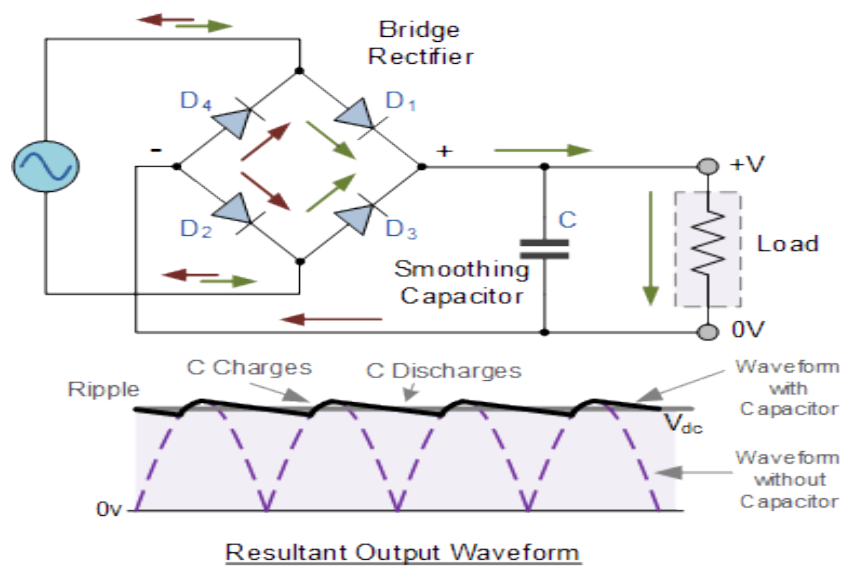
1- Half-wave rectifier:



2- Full-wave rectifier:



3- Full-wave bridge rectifier:

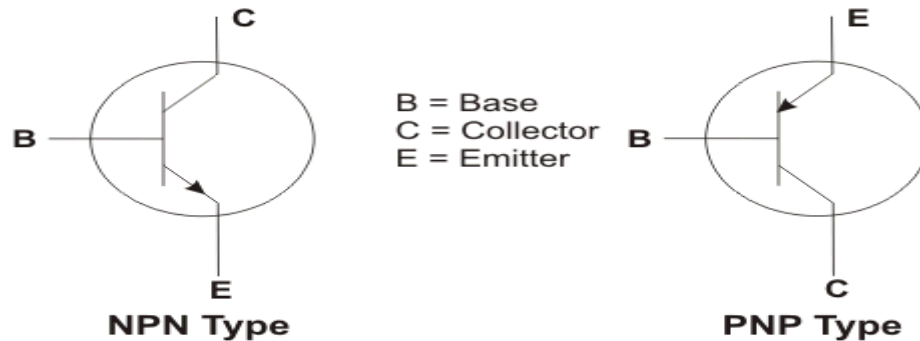


Q31: When a voltage drop occurs at a generator connected to the grid, what needs to be done to raise it again?

A31: Assuming the drop is not caused by faults, a voltage regulator is used to raise the voltage to the desired value of the generator.

Q32: Draw the transistor and explains how it works?

A32: A transistor is an electronic semi-conductor component that can work either as a switch or amplifier. The transistor is like an electronic switch. It can turn a current on and off. In a standard NPN transistor, you need to apply a voltage of about 0.7V between the base and the emitter to get the current flowing from base to emitter. When you apply 0.7V from base to emitter you will turn the transistor ON and allow a current to flow from collector to emitter.



Q33: How to isolate a transformer without affecting the consumer?

A33: Transformers connected in parallel can be easily isolated without affecting the load if back up transformer is also connected. If there is no backup transformer then it is possible to distribute the load to the remaining transformers if it doesn't cause overloading until the isolated transformer is back in service.

Q34*: What is the slip? percentage slip? And how much is it in induction and synchronous motors?

A34:

- **Slip** is the speed difference between the rotating magnetic field and the rotor:

$$Slip = N_s - N_r$$

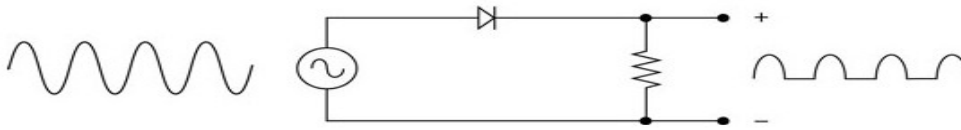
- **Percentage slip** is given by: $Slip\ percentage = \frac{N_s - N_r}{N_s}$

(Ns: Rotating magnetic field speed in RPM. Nr: Rotor speed in RPM.)

- In synchronous motor the slip is zero while in induction motors is usually below 1% for high horse power motors while in low horse power motors it can reach up to 5%.

Q35*: What are rectifiers? Explain how they work?

A35: Rectifier is an electronic circuit that utilizes the switching properties of diodes to convert an AC signal to a DC signal. Since the diode will not conduct current unless it meets a certain value (typically 0.7 V) The negative half of the AC signal will not pass, thus creating a positive signal that can be smoothed to a constant dc signal.

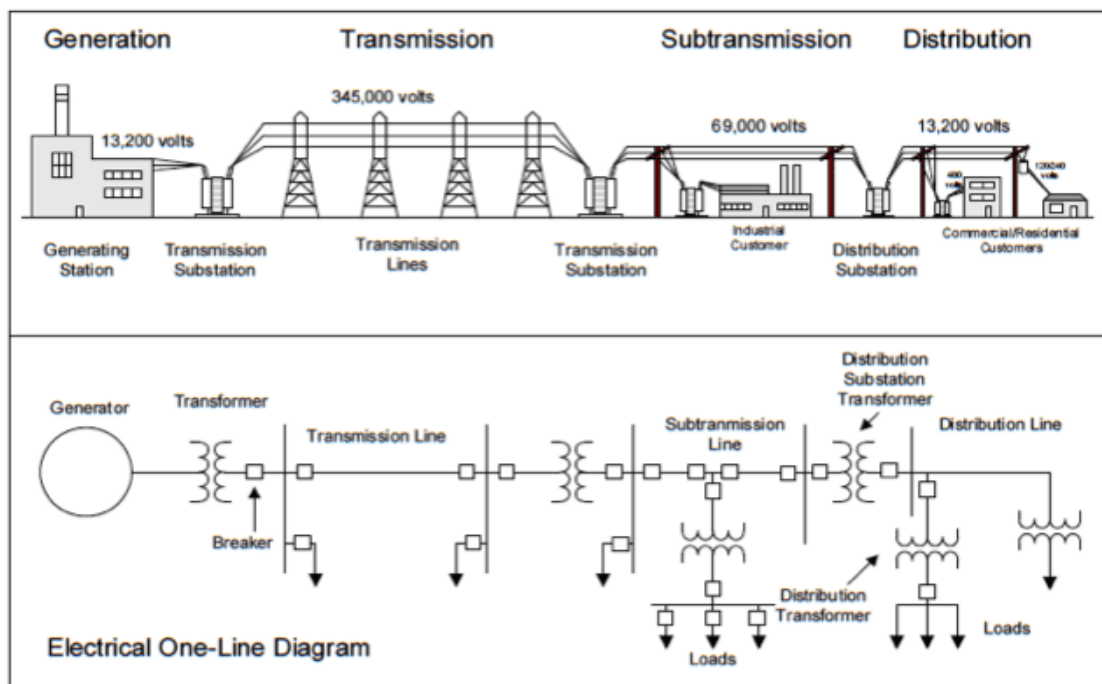


Q36*: What are inverters? Explain how they work?

A36: Inverters utilize the switching properties of diodes and thyristors to convert a DC signal to AC signal. A switching occurs 60 times in a second (because the frequency is 60 Hz) resulting in a square wave signal that goes through a filter or smoothing coil to output an AC sinusoidal wave.

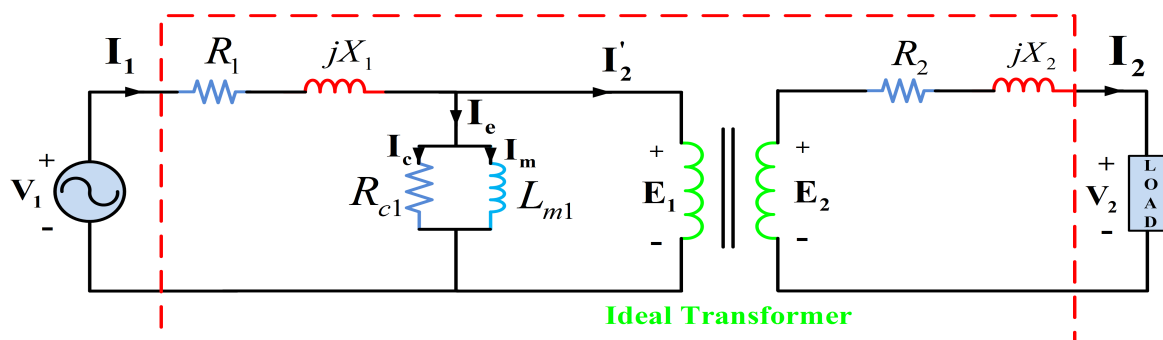
Q37: Draw the single line diagram of a typical power system?

A37:



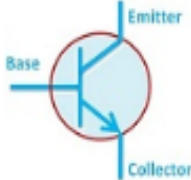
Q38: Draw the equivalent circuit of the transformer?

A38:



Q39: What are the differences between diodes and transformers?

A39:

PARAMETERS	DIODE	TRANSISTOR
Definition	A diode is a two terminal device which allows current to pass in one direction only.	Transistor is a three terminal device which allows current to flow from high resistance region to low resistance region
Formation	It is formed by joining a P-type semiconductor with N-type semiconductor.	It is formed by sandwiching a layer of P-type or N-type material between two N-type or P-type material on either end.
Circuit Symbol		
Depletion Layer	Only one depletion region is formed.	Two depletion region are formed.
Number of Junctions	Only one junction between P-type and N-type semiconductor.	Two Junctions are formed one in between emitter and base and other between base and collector.
Terminals	2 terminals are there in a diode i.e. anode and cathode.	3 terminals are there in transistor i.e. emitter, base and collector.
Considered as	It can be considered as a switch.	It can be considered as a switch or an amplifier.
Applications	Rectifier, voltage double, clipper etc.	Amplifier, Oscillator etc.

Q40*: What are the advantages of 60 Hz over 50 Hz and vice-versa?

A40: refer to the equation: $V = 4.44 f n \Phi_m$

- at $f = 60$ Hz we can generate more voltage compared to 50 Hz.
- However more voltage generated means more losses on equipment and transmission lines compared to 50 Hz.

As a result, the choice depends mainly on economic studies done by the countries.

Q41*: What are the differences between wound rotor and squirrel cage ac motors?

A41:

Wound Rotor	Squirrel Cage
The rotor windings are easily identifiable and visible.	The windings are inside of what looks like a cage between two slip rings encased by bars
The rotor is fed by external supply to increase the torque.	The rotor is never fed by external supply, thus has less torque.
Because of the rotor being supplied by external source it requires conducting brushes. Resulting in less durability and more maintenance.	No conducting brushes needed, more durable and requires less maintenance.

Q42*: How to change the direction of DC and AC motors?

A42:

- **DC motors:** reverse the polarity of the supply on the field OR the armature.
- **AC motors:** switch any two phases.

Q43*: What controls the real power and reactive power produced by the generator?

A43:

- **Real power:** Controlled by the governor which rotates the turbine.
- **Reactive power:** Controlled by the excitation voltage.

Q44*: State the generator synchronizing conditions?

A44:

- 1- The magnitude of the rms line voltage must be the same (+/-5% is allowed).
- 2- Frequency of the incoming generator must be same or slightly higher than the grid (+0.067 Hz is allowed).
- 3- Phase sequence must be the same.
- 4- Phase angle must be the same (-/+10° is allowed) .

Q45*: What is the difference between single line diagram and schematic diagram?

A45:

- **Single line diagram:** Shows only the power system elements and the power flow.
- **Schematic diagram:** Shows the control elements and how the system is controlled.

Q46*: Why the high voltage is usually the farthest from the transformer core?

A46: For two reasons:

- 1- Because the HV has many turns, keeping it away from the core will reduce the insulation.
- 2- So the tap changer can be easier to install and operate.

Q47*: State the tap changer types? What are the tap changers components and what they do?

A47: - There are two types of tap changers:

1- Off-load tap changer: The transformer must be disconnected before changing active number of turns.

2- On-load tap changer: Can operate while the transformer is live.

- Tap changer components are:

1- Selector switch: selects the tap on the transformer to determine active number of turns.

2- Reactor: limits the current circulating due to the voltage difference between tap positions.

3- Vacuum circuit breaker: makes or breaks load current when necessary for protection.

4- Bypass switch: operates during the tap changing operation.

Q48*: What are the common types of cooling systems in a transformer?

A48:

1- ONAN (Oil Natural – Air Natural).

2- ONAF (Oil Natural – Air Forced).

3- OFAF (Oil Forced – Air Forced).

Q49*: What are the advantages and disadvantages of using oil in electrical equipment such as a transformer?

A49:

- **Advantages:** 1- Excellent heat transfer properties. 2- Excellent insulating properties.

- **Disadvantages:** 2- Fire or explosion risk. 2- Pollution to the environment.

Q50*: State the parallel operation conditions for transformers? Which are essential?

A50:

1- Polarities of each transformer must be the same. → **Essential**

2- The turn ratio of each transformer must be the same. → **Essential**

3- The full load voltage across each transformer internal impedance should be the same.

4- The ratio of each transformer resistances to reactances should be the same to ensure they all operate at the same power factor.

Q51*: What does “Dyn11” means on the nameplate of the transformer?

A51: The High-Voltage winding is delta connected, the Low-Voltage winding is star connected with a brought out neutral and a phase shift of 30° leading.

Q52*: Explain the short and open circuit tests for the transformer?

A52:

1- Open circuit test: The High-Voltage side is open circuit and rated voltage is applied to the low voltage side. Its main objective is to find the core losses and do noise tests.

2- Short circuit test: The Low-Voltage side is short circuited and low voltage is applied at the High-Voltage side until rated current appears. Its main objective is to find copper losses and do temperature rise tests.

Q53*: What are motor drives? What's their purpose?

A53:

- Electric motor drive is a system made up of electronic devices like rectifiers and inverters and micro controllers to control the behavior of the motor mainly through the speed by adjusting the voltage and/or the frequency supplied to the motor..
- Motor drives serve three purposes: 1- Saving power and money. 2- Control the motor. 3- Protect the equipment.

Q54*: State the famous types of motor drives?

A54:

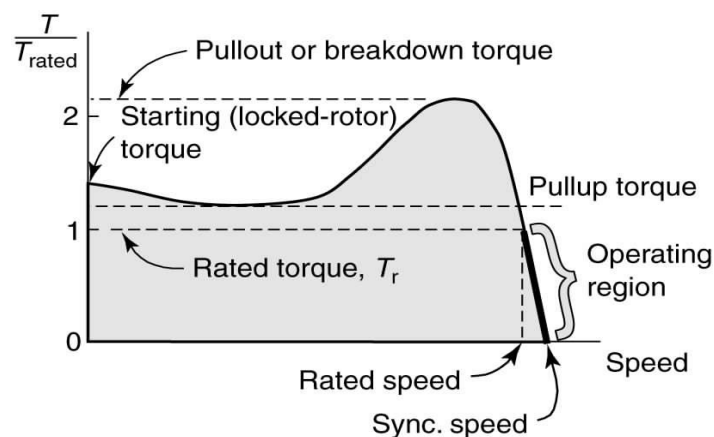
- 1- Variable speed drives (VSD).
- 2- Adjustable speed drives (ASD).
- 3- Variable frequency drives (VFD).
- 4- Adjustable frequency drives (AFD).

Q55*: What is the relationship between the torque and power in a motor?

A55: $P = \frac{T * N}{9549}$ P: Power in KW. T: Torque in Nm. N: Speed in RPM

Q56*: Draw the speed-torque characteristic of a typical induction motor?

A56:



Q57*: What is the Switchgear? What are its components?

A57: Switch gear is a term used to describe the various components used to distribute electrical power. It has 6 components:

- 1- Circuit breakers:** They are switching devices and current interrupters.
- 2- Busbars:** Metallic bars that connect various components in the system. Can be 5 types: open, enclosed, compound immersed, oil immersed, and compressed gas insulated.
- 3- Instrument transformers:** step down transformers used for protection, control, and measurements.
- 4- Disconnect switches (Isolators):** A switching device to isolate the equipment, never to be used to interrupt current.
- 5- Grounding switches:** to connect to the ground when needed.
- 6- Protective relays:** sensing devices that make measurements and send signals to the breakers.

Q58*: What are the components that constructs a circuit breaker?

A58: 1- Stationary contacts. 2- Moving contacts. 3- Arc chute. 4- Tripping element. 5- Operating mechanism.

Q59*: State some of the types of circuit breakers?

A59: 1- Air circuit breaker. 2- Air-Blast circuit breaker. 3- Oil circuit breaker. 4- Vacuum circuit breaker. 5- SF6 circuit breaker.

Q60*: Why batteries cannot be charged by an AC supply?

A60: Because the battery will keep charging in the positive half cycle then discharge immediately in the negative half cycle the battery will never charge. Unlike in DC where the current is constantly positive.

Q61*:What are the issues with low power factor?

A61: lower power factor systems will cause the equipment to draw more current. As a result:

- 1- The equipment must withstand higher current otherwise they will be damaged.
- 2- Higher power losses.
- 3- Higher voltage drops in the equipment, resulting in poor voltage regulation.

Q62*: State some of the ways we can reduce the starting (inrush) current of a motor?

A62: 1- Using motor drives. 2- Reducing the load. 3- Reducing the applied voltage.

Q63*:What are the relations between the following in a motor:

- 1- Rotor current and torque?
- 2- Speed (and frequency) and torque?
- 3- applied voltage on the stator and speed?

A63:

- 1- Proportional.
- 2- Inverse-Proportional.
- 3- Proportional.