Q-1 State the advantages of interconnection in power system. OR What is the importance of interconnected power system? OR List the advantages and disadvantages of interconnected power systems.

The power system network is an interconnected network. It means all generators are connected with the grid. Therefore, if one generator is overloaded the load can be transferred on other generators. There are many advantages and disadvantages of the interconnected system. Let us start with the advantage of interconnected power system.

1. Use of older plants
2. Economical operation
3. Increase the reliability of power supply
4. Exchange of peak load
5. Increase the diversity factor
6. Reduce plant reserve capacity
7. Reduce capital and operating cost

This advantage is discuss in brief

1. Use of older plants:

In the power system network, there are some old and insufficient generating stations. These stations have the capacity to carry short peaks of the load. But these generating stations are not sufficient to run on a continuous basis.

If the system is interconnected than these plants are also connected in a system with a transmission line and we can use these plants to meet the peak load demand. So, to achieve this purpose, these generating stations are used with modern plants.

In this way, we can meet peak load demand without giving extra burden on modern plants with the help of old and insufficient generating station.

2. Economic Operation:

All the generating stations are working on the same frequency and same voltage level. Because of the sharing of load among the power plants are done in such a way that all generating stations can work continuously with high efficiency and high-power factor.

The less efficient and old generating stations are not used continuously and these plants are used only at peak hours. Therefore, in an interconnected system makes the economical operation of the power stations.

3. Increase the Reliability of Power Supply:

In the interconnected power system, all the load has more than one supply. If one supply is failed or in maintenance, in this condition load is supplied by another source.
So, if a major breakdown occurred in the power station, then the load is transferred to other healthy power station. Hence, the load is always connected with an uninterrupted power supply and increases the reliability of the system.

4. Exchange of Peak Load:

In the summer season, the use of inductive load like air-conditioner is increase. Therefore, in this season, the load curve of the power station shows a peak demand.

This peak demand is more than the capacity of that power system. In this condition, an extra load must be shared by other power station, otherwise, overload relay may operate and load shedding will be done to reduce the burden on a power station.

In the interconnected system, the peak load is transferred to the old generating station. So, the load curve will remain flat in peak demand conditions.

5. Increase Diversity Factor:

It is a ratio of the sum of the individual maximum load of various plants of the system to the maximum demand of the entire system.

The load curve is not the same for all generating stations connected in the interconnected power system. In this way, the maximum demand for the system is reduced as compared to the sum of individual maximum demands on various power stations. And the diversity factor of the system is improved. Therefore, the effective capacity of plants is increased.

6. Reduce Plant Reserve Capacity:

Every power plant has a standby unit for emergencies. In the interconnected system, all plants are connected in parallel. So, the reserve capacity of the system is reduced and it increases the efficiency of the system.

7. Reduce Capital and Operating Cost:

In an interconnected system, the efficiency of plants is increased and the cost of power generation is reduced. In this system, capital cost and operating cost is reduced. So, per kW price is also reduced.

As every coin has two side same as interconnected power system also has some disadvantages. The drawback of interconnected power system is

1. Expensive tie line:

The interconnected power system required more number of expensive tie line for reliability and security of power system which increase the capital cost of transmission line.

2. Voltage and frequency control:
It is difficult to control the voltage of all bus in interconnected power system. The voltage fluctuation is always present in interconnected power system due to switching of load and fault condition. So, it is required to add reactive power source in interconnected power system to maintain voltage profile constant. The frequency is also varies due to unbalance between generation and load demand. So, scheduling of interconnected power system is the key parameter to handle the grid frequency.

3. Synchronizing Problem:

In an interconnected power system, all the generators are connected in parallel and it must operate at the same frequency.

If this does not happen than any generator of the system may go to out of step condition because of the synchronization breakup.

In the worst condition, the blackout condition may create. So, it is a necessary condition to operate all the generating stations in the synchronized manner.

4. Metering and Instrumentation:

At a different stage of power system network, meters and sensors placed to measure the quantities like voltage, current, frequency, active power, reactive power, etc.

These meters and instruments are very costly. For load forecasting and future calculation, a record of this measurement we required. So, it is necessary to install a sequential recorder, disturbance recorder, etc.

5. Shortage of Reserve Capacity:

In the case of peak load, the load demand is more than the power generation. In this condition, if every power station has a certain amount of reserve power then it can be used to meet demand. This is also useful to meet minute to minute variation in load and load forecasting error.

This can be classified into two types: cold reserve and an operating reserve.

Q-2 Explain cascading tripping. OR Explain cascade tripping in power system. OR Discuss steps of black start. OR What is black out? What are its effects?

Power system equipment is designed to operate within certain limits.

Most of power system equipment are protected by automatic devices that can cause equipment to switch out of system if this limits are violated.

If any events occurs on a system which makes operating limits violated, the event may be followed by series of further actions that switch other equipment out of service.

If this process of cascading failures continues, the entire system or larger parts of it may completely collapse.
Chapter-1 Introduction

This is usually referred as *Cascade Tripping* or *System Blackout*.

Example-1 A generating unit may have to be taken off-line because of auxiliary equipment fails, if system does not maintain proper spinning reserve then all generator trip one by one and system collapse.

Example-2 A single transmission line being opened due to insulation failure and remaining transmission line is now to heavily overloaded, it may open due to relay action. Due series of failure all system collapse.

Two severe power blackouts affected most of northern and eastern India on 30 and 31 July 2012. The 30 July 2012 blackout affected over 40 crore (400 million) people and was briefly the largest power outage in history by number of people affected, beating the January 2001 blackout in Northern India. All major power stations were shut down in the affected states, causing an estimated shortage of 32 GW.

A black start is the process of restoring an electric power station or a part of an electric grid to operation without relying on the external electric power transmission network to recover from a total or partial shutdown.

Generating plants using steam turbines require station service power of up to 10% of their capacity for boiler feed water pumps, boiler forced-draft combustion air blowers, and for fuel preparation. It is uneconomical to provide such a large standby capacity at each station, so black-start power must be provided over designated tie lines from another station. Often hydroelectric power plants are designated as the black-start sources to restore network interconnections. A hydroelectric station needs very little initial power for starting purposes (just enough to open the intake gates and provide excitation current to the generator field coils), and can put a large block of power on line very quickly to allow start-up of fossil-fuel or nuclear stations.

One method of black start (based on a real scenario) might be as follows:

1. A battery starts a small diesel generator installed in a hydroelectric generating station.
2. The power from the diesel generator is used to bring the generating station into operation.
3. Key transmission lines between the station and other areas are energized.
4. The power from the station is used to start one of the nuclear/fossil-fuel-fired base load plants.
5. The power from the base load plant is used to restart all of the other power plants in the system.
6. Power is finally re-applied to the general electricity distribution network and sent to the consumers.

Q: What is the concept of Islanding? State its important advantages. OR Explain network islanding phenomenon.

*Islanding* is the condition in which a distributed generator (DG) continues to power a location even though electrical grid power is no longer present.
Chapter 1 Introduction

Islanding can be dangerous to utility workers, who may not realize that a circuit is still powered. But it may prevent by automatic disconnection of devices.

Additionally, the balance between load and generation in the islanded circuit is going to be violated without strict frequency control and leading to abnormal frequencies and voltages. For those reasons, distributed generators must detect islanding and immediately disconnect from the circuit; this is referred to as anti-islanding.

A common example of islanding is a distribution feeder that has solar panels attached to it. In the case of a power outage, the solar panels will continue to deliver power as long as irradiance is sufficient. Solar inverters that are designed to supply power to the grid are generally required to have some sort of automatic anti-islanding circuitry.

The main advantage is the continuous power supply for selective area without effecting the utility of that area.

Q-4 Explain automatic load despatch in power system also explain the importance of regional load despatch center. OR Explain the main features of Load Despatch center. OR State the names of load despatch center in hierarchical order and explain its functioning.

Load despatch center is a coordinating agency for state electricity boards for ensuring a mechanism for safe and secure grid operation. Load despatch center is an important link between generation and transmission, which coordinates the power requirements of consumers of electricity. Load Despatch center which is the nerve of our power system is used to perform various functions.

The hierarchical arrangement of Indian load despatch center is given in below chart.

![Hierarchical arrangement of India Load Despatch Center](image)
1. **Function of NLDC:**
   - NLDC is national body which supervise on all regional load dispatch center.
   - NLDC makes scheduling (Planning of generation according to load demand) and dispatch (Determining economical availability of generation) in coordination with regional load dispatch center.
   - NLDC works according to the grid standard and grid code given by center commission.
   - NLDC monitor operation and security of national grid.
   - NLDC coordination with regional load dispatch center for regional outage schedule in the national perspective to ensure optimal utilization of power resources.
   - NLDC coordination with regional load dispatch centers for the energy accounting of inter-regional exchange of power.
   - NLDC coordination for trans-national exchange of power.
   - NLDC is an authority to levy and collection of such fee and charges from the generating companies or licensees involved in the power system, as may be specified by the Central Commission.

2. **Function of RLDC:**
   - The RLDC shall be the apex body to ensure integrated operation of the power system in the concerned region.
   - The RLDCs shall comply with such principles, guidelines and methodologies in respect of wheeling (Transportation of electrical power), optimum scheduling and despatch of electricity as specified by the Central Commission in the Grid Code.
   - RLDC monitor regional grid operations.
   - RLDC keep accounts of quantity of electricity transmitted through the regional grid.
   - RLDC exercise supervision and control over the inter-State transmission system.
   - RLDC is responsible for carrying out real time operation for grid control and despatch of electricity within the region through secure and economic operation of the regional grid in accordance with the Grid standards and Grid code.

3. **Function of SLDC:**
   - The SLDC shall be the apex body to ensure integrated operation of the power system in a State.
   - SLDC monitor state grid operations.
   - SLDC keep accounts of quantity of electricity transmitted through the inter-state grid.
   - SLDC exercise supervision and control over the inter-State transmission system.
   - SLDC is responsible for carrying out real time operation for grid control and despatch of electricity within the state through secure and economic operation of the grid in accordance with the Grid standards and Grid code.
   - SLDC is an authority to levy and collect such fee and charges from the generating companies and licensees engaged in State transmission of electricity as may be specified by the State Commission.
Q-5 Explain power generation scenario in Gujarat from fuel used in power generation point of view.

Power generation is done by three type of power generating authority in India.

1. Central Power Generating Station
2. State Power Generating Station
3. Private Power Generating Station.

The table gives the power generating capacity in MW of different entity in Gujarat.

<table>
<thead>
<tr>
<th>Sector</th>
<th>MW</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Sector</td>
<td>1,996.89</td>
<td>5.43%</td>
</tr>
<tr>
<td>State Sector</td>
<td>9,790.17</td>
<td>26.52%</td>
</tr>
<tr>
<td>Private Sector</td>
<td>25,116.49</td>
<td>68.05%</td>
</tr>
<tr>
<td>Total</td>
<td>36,903.55</td>
<td></td>
</tr>
</tbody>
</table>

Gujarat has 64.44% of thermal power generation which has capacity of 23,783 MW, based on coal or gas as fuel. Gujarat has 1990 MW generating capacity of hydro power plant and 440 MW of nuclear power plant. The renewable energy contribution is about 10,690 MW from wind and solar energy which is about 29% of total energy generation of Gujarat. The total generating capacity of Gujarat is about 36,904 MW.