Q1) Explain the different types of PMSM Motors based on the rotor structure with near diagrams

A)

Classification according to rotor arrangement. (A) Surface-mounted permanent magnet synchronous motor (SPMSM) and (B) interior permanent magnet synchronous motor (IPMSM).

a)**The permanent magnet of the SPMSM is located at the surface of the rotor and the inductance in the motor will be lower. This allows to achieve a high current response. Moreover, because the reluctance torque is not generated, the torque has a strong linearity. Therefore, the SPMSM can be applied in fast respond servo-drive. To get rid of the leakage between the permanent magnet and the stator wire, the valid flux linkageis possible and the flux distribution of the capacitor does not include much harmonics; hence, the noise and ripple are small.**

Drawback: Permanent magnet can be damaged due to centrifugal force

b)**The design of the IPMSM's structure addresses the SPMSM's weakness, reduces the valid air gap by putting the permanent magnet inside of the rotor, and improves the robustness of mechanical strength. The surface of the rotor is laminated with a silicon sheet so that the eddy current loss can be lowered and flux weakening can be easy. Moreover, the salient characteristic of the permanent magnet arrangement is that the reluctance torque is generated. The IPMSM is suitable in the cases where the load changes considerably and the flux weakening region exists such as servomotorand motor of electric-hybrid and electric cars.**

Drawback: Decrease in the valid flux

Q2) Explain why PMSM does not require an external excitation and how it affects the efficiency value when compared with traditional synchronous motors

A)**Why PMSM does not require external excitation**

In a traditional synchronous motor (with a field winding on the rotor), you need external DC excitation.

- **This is supplied either through slip rings and brushes or via a rotor-mounted rectifier/auxiliary exciter.**
- **The excitation current produces the rotor magnetic field required for synchronous operation.**

In a Permanent Magnet Synchronous Motor (PMSM), the rotor already has permanent magnets embedded or surface-mounted.

- **These magnets provide the constant rotor flux.**
- **Hence, no DC field current or excitation system is required.**

How this affects efficiency compared to traditional synchronous motors

Traditional synchronous motor:

- **Needs rotor field current → causes I^2R (copper) losses in the rotor winding.**
- **Also has some additional power electronics/excitation system losses.**
- **Brush/slip ring arrangements add frictional losses and require maintenance.**

PMSM:

- **No rotor copper loss (since no field winding).**
- **Only stator copper loss and core (iron) losses remain.**
- **Overall, lower losses → higher efficiency.**

Q3) Why does a PMSM have better power factor when compared to Induction Motor?

A) Induction Motor (IM)

In an induction motor, the rotor does not have a permanent magnetic field.

The stator must supply both:

1. **Magnetizing current → to establish the air-gap flux.**
2. **Torque-producing current → to generate mechanical power.**

Permanent Magnet Synchronous Motor (PMSM)

In PMSM, the rotor already has permanent magnets, which provide the required air-gap flux.

- **Therefore, the stator current is almost entirely torque-producing (active).**
- **Very little reactive component is needed.**