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**MATRIC NO: 17/ENG04/069**

**DEPARTMENT: ELECTRCAL ELECTRONICS ENGINEERING**

**EEE 326 ASSIGNMENT**

**ELECTRICAL MACHINES II**

1. **Discuss the effects of harmonics on synchronous machines**

Distortion in Flux distorts EMF induced and creates Harmonics in EMF Wave. Harmonics mean EMF has higher Frequency components. Harmonics increase Losses in Transmission Line due to Skin Effect and Iron Loss in Transformers connected to Generator. 5th Harmonic produces retarding Torque in Induction Motor. 7th Harmonics may produce Crawling in Induction Motor i.e. Induction Motor may start running at 1/7thSpeed. In synchronous machines, voltages and currents are induced, which are in sinusoidal waveforms. But in practice, these sinusoidal waveforms will deviate to form non-sinusoidal waveforms.  
These non-sinusoidal waveforms are expressed in terms of Fourier transforms which are the sum of series of sinusoidal waveforms.

Voltage Harmonics Produced by Synchronous Machines.

If the magnetic flux of the field system is distributed perfectly sinusoidal around the air gap, the e.m.f. (electro motoric force) generated in each full-pitched armature coil is

e.m.f. = 2πfφ.sinωt [V per turn] (1)

Where f is the total flux per pole and f is frequency related to speed and pole pairs. However the flux is never exactly distributed in this way, particularly in salient pole machines. The magnitudes of the harmonic e.m.f.s are determined by the harmonic fluxes the effective electrical phase spread of the winding, the coil span, and the method of interphase connection. Iron losses such as eddy current and hysteresis losses, are produced in the core of motors and generators due to the alternating magnetic field. The amount of eddy current loss varies as the square of the frequency, while hysteresis loss is directly proportional to frequency. Thus, higher frequency voltage components (i.e. harmonic voltages) generate additional losses, which result to higher operating temperature of the core and the surrounding windings.

1. **State how they affect synchronous motors; state how they affect synchronous generators)**

The detrimental effects of harmonics on motors and generators are usually taken for granted due to complacency or lack of knowledge. For example, the increase application of variable frequency drives (VFD) has subjected motors to considerably higher harmonic levels compared to when it was still using traditional controllers. As a consequence, the machine efficiency and torque developed are significantly affected. Harmonic currents can give rise to excessive audible noise emission and vibration due to the difference between time harmonics and frequencies.

**Motors**

Core and stray losses may become significant for an induction motor with skewed rotors. Single-phase motors are the most affected.

**Generators**

The heating effect of nonlinear loads on generators is greater compared to transformers. This is because a generator has higher reactance and impedance, that when paired with high frequency flux changes could cause stator heating. Also, high frequency currents will induce currents in the pole faces and hunting winding and hence cause rotor heating. Subsequently, generators supplying nonlinear loads should be derated based on the generator reactance.

1. **Justify technically why the stator windings of large generators are star connected**

Alternators are connected primarily in star to achieve the following motives:  
Lesser stress on [insulation](https://www.dieselgeneratortech.com/generator-sets/How-to-Test-The-Insulation-Level-of-Diesel-Generator-Sets.html) and Copper saving: Voltage per phase is less for a given line voltage which reduces insulation requirement and this also reduces the number of turns hence copper is also saved.  
Easy protection: Neutral grounding is necessary to allow zero sequence currents to flow to the ground in case of a fault.  
Elimination of harmonics: Star connection facilitates a neutral connection which is instrumental in eliminating triple harmonics.  
No circulating currents: In star connection we don't have circulating parasitic currents like in delta which lead to heating losses.

1. **Why is it that the armature for large machines is stationary?**

The reasons are listed below:

* It is easier to insulate stationary winding for high voltages for which the alternators are usually designed. It is because they are not subjected to centrifugal forces and also extra space is available due to the stationary arrangement of the armature.
* The stationary 3-phase armature can be directly connected to load without going through large, unreliable slip rings and brushes.
* Only two slip rings are required for d.c. supply to the field winding on the rotor. Since the exciting current is small, the slip rings and brush gear required are of light construction.
* Due to the simple and robust construction of the rotor, the higher speed of rotating DC field is possible. This increases the output obtainable from a machine of given dimensions.

1. **Why do brushless generators undergo less maintenance?**

Less brushes, abrasion of brushless generator is mainly on bearings, from the view of a mechanical point, brushless generator is almost a maintenance-free motor, when necessary, just need to do some dust removal maintenance. Brushless generator has no electric brush, friction is greatly reduced when running, running smoothly so that noise will be reduced a lot, and this advantage is also a huge support for the stability of the model operation. The brushless system have benefits of reduced regular maintenance due to elimination of brushes and reduced unscheduled maintenance due to redundancy; causing a reduced cost-of-energy.