Three-phase transformer connections and Vector groups :-

A Bank of three transformers or a 3-phase transformer may have its primary and secondary windings connected in star, delta or zig-zag. The choice of particular connections depends upon the service conditions. The commonly employed connections are star, delta, zig-zag and these are designated by the symbols Y, D and Z respectively. Zig-zag connection is also called inter-connected star or "interstar".

Polyphase (three phase) transformers are allotted symbols giving the type of phase connection and the angle of advance turned through in passing from the vector representing the h.v. emf to that representing the l.v. emf — at the corresponding terminal. The angle may be indicated by a clock face hour figure, the h.v. vector being the 12 o'clock (zero) and the corresponding l.v. vector being represented by the hour hand. Thus, "Yd11" represents a (h.v. star and l.v. delta connected) three-phase transformer with the l.v. emf vector at 11 o'clock position i.e., $+30^\circ$ in advance of the h.v. emf which is at 12 o'clock position.

Depending on the phase displacement of the voltages of h.v. and l.v. sides, the transformers are classified into groups called 'Vector groups'. Transformers with the same phase displacement between the h.v. and l.v. sides are classified into one group. For satisfactory parallel operation of transformers, they should belong to the same vector group. For example, a star-star connected three-phase transformer (or bank of three single-phase transformers)

can be connected in parallel with another 3-phase transformer (or bank of three single-phase transformers) whose windings are either star-star or delta-delta connected. A star-star connected transformer cannot be connected in parallel with another star-delta connected transformer as this may result in short-circuiting of the secondary side.

The groups into which all possible three-phase transformer connections are classified as-

group-1 : Zero degree phase displacement
(Yy0, Dd0)

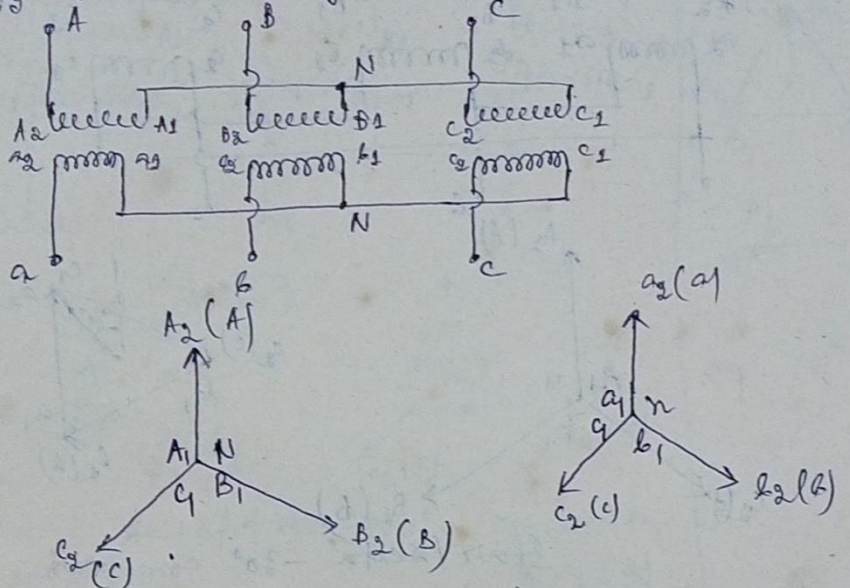
group-2 : 180° phase displacement
(Yy6, Dd6)

group-3 : 30° lag phase displacement
(Dy1, Yd1)

group-4 : 30° lead phase displacement
(Dy11, Yd11).

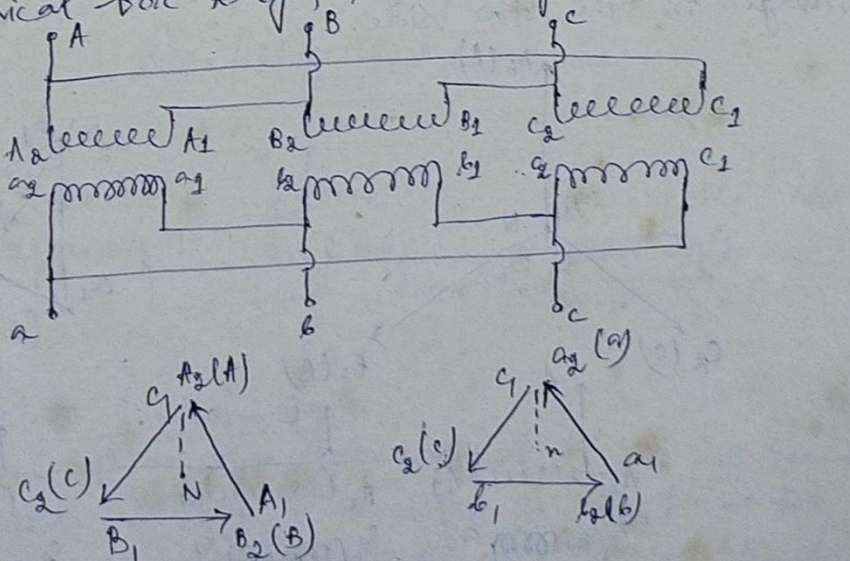
Three-phase transformer connections :-

(1) **Star/Star (Y/Y) - connection :-** This connection is most economical for small high voltage transformers, because the number of turns/phase and the amount of insulation required is minimum (as phase voltage is only $\frac{1}{\sqrt{3}}$ of line voltage).



Star/Star 0° connection

(2) **Delta/Delta (Δ/Δ) - connection :-** This connection is economical for large, low voltage transformers.



Delta/Delta 0° connection