

Max marks - 15

Time - 1 Hour

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Electronics Department

II Test Power Electronics (EL 305)

Teacher Name - BHAWNA MATH

Q1 Describe a phase control circuit of an SCR using a transformer.

Ans 1 Pulse transformers are used quite often in firing circuits for SCRs. This transformer has usually two secondaries. The turn ratio is 2:1:1 or 1:1:1. These transformers are designed to have low winding resistance, low leakage reactance and low interwinding capacitance.

A square wave pulse at the primary terminals of a pulse transformer may be transmitted at its secondary terminals faithfully as a square wave or it may be transmitted as a derivative of the input wave.

In trigger circuit using a pulse transformer is shown in Fig. Here the function of the diode is to allow the flow of current after the pulse period (i.e. when the transistor is off) so that energy stored in the primary of pulse transformer is dissipated.

The transistor is acting simply as a switch, turning on when the pulse applied to its base is at its high level, thereby connecting the dc bias V_B to the transformer primary.

The advantage of this arrangement is -

(1) There need not be a variable strength pulse generator since the pulses may be of the same amplitude and the strength of the

Generated pulses may be increased simply by varying the d.c. bias voltage.

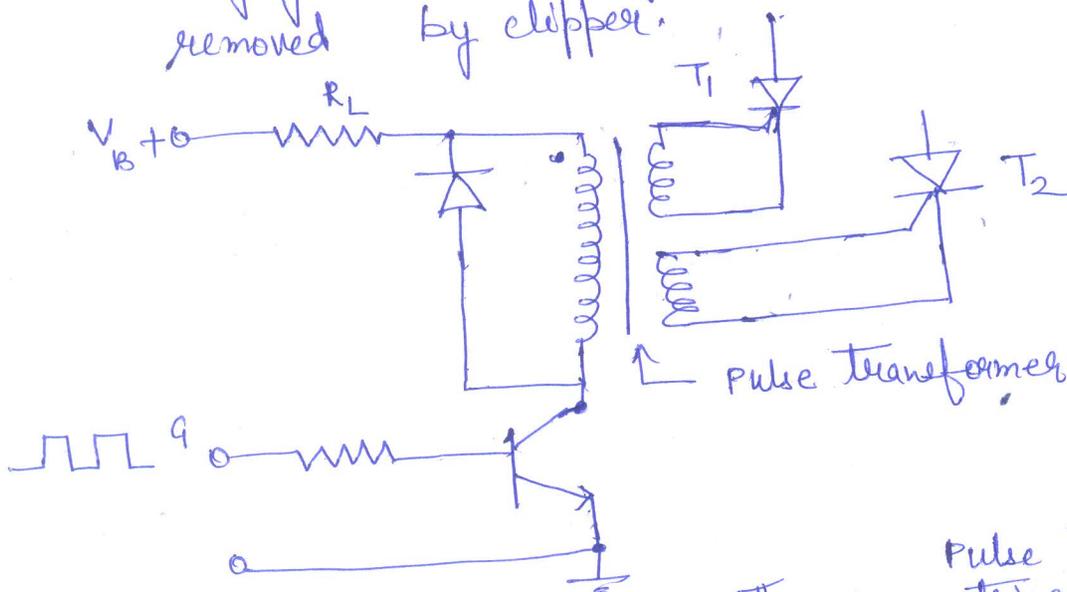
(ii) The operation of the circuit becomes independent of the pulse characteristics since the only role the pulse plays is to turn on or turn off the transistor.

R_L limits the current in the primary circuit of pulse transformer. It's equivalent circuit is shown. L is the magnetizing inductance of the pulse transformer and R_g is the resistance of gate-cathode circuit of an SCR.

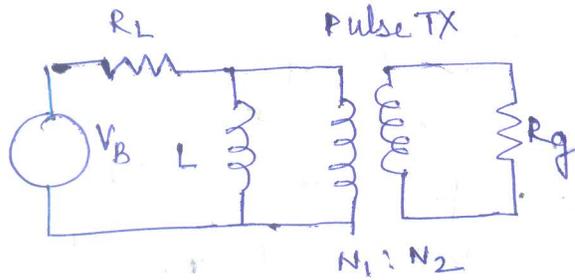
In Fig 3 it is shown that the transfer of R_g to pulse transformer primary as $R_1 = \left(\frac{N_1}{N_2}\right)^2 R_g$.

~~This circuit can be analysed by applying a~~ It is seen that for a step rise in input voltage, the pulse transformer output is positive pulse.

Likewise, for a step fall in i/p voltage, a negative pulse appear at the pulse transformer o/p. If the pulse transformer has large inductance the pulses are faithfully reproduced and if inductance is small, the pulses are exponentially decaying pulses. Negative going pulse is removed by clipper.



Pulse transformer
circuit



Equivalent circuit
Fig 2

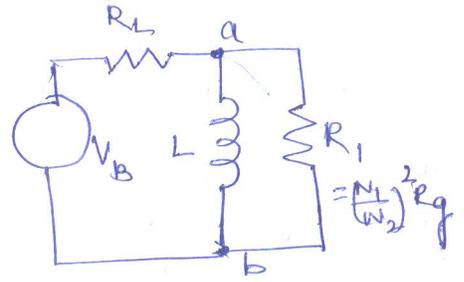


Fig 3

Q. N2 Explain the working of a three phase full wave rectifier using diodes.

Ans 2 In this rectifier 6 diode and three phase supply is used. A three phase transformer with primary in delta and secondary in double star is used. One diode in each phase is connected. Secondary of each phase winding is in two halves. The mid points of the three secondary windings are connected to form the neutral n.

Six phase supply is available from six terminals $a_1, c_2, b_1, a_2, c_1, b_2$. Phase voltages V_{a1}, V_{b1}, V_{c1} are phase displaced by 120° , similarly V_{a2}, V_{b2}, V_{c2} are displaced by 120° . But V_{a1} and V_{a2} are out of phase by 180° . However; V_{a1}, V_{c2} are out of phase by 60° , as shown in

Fig 2 =

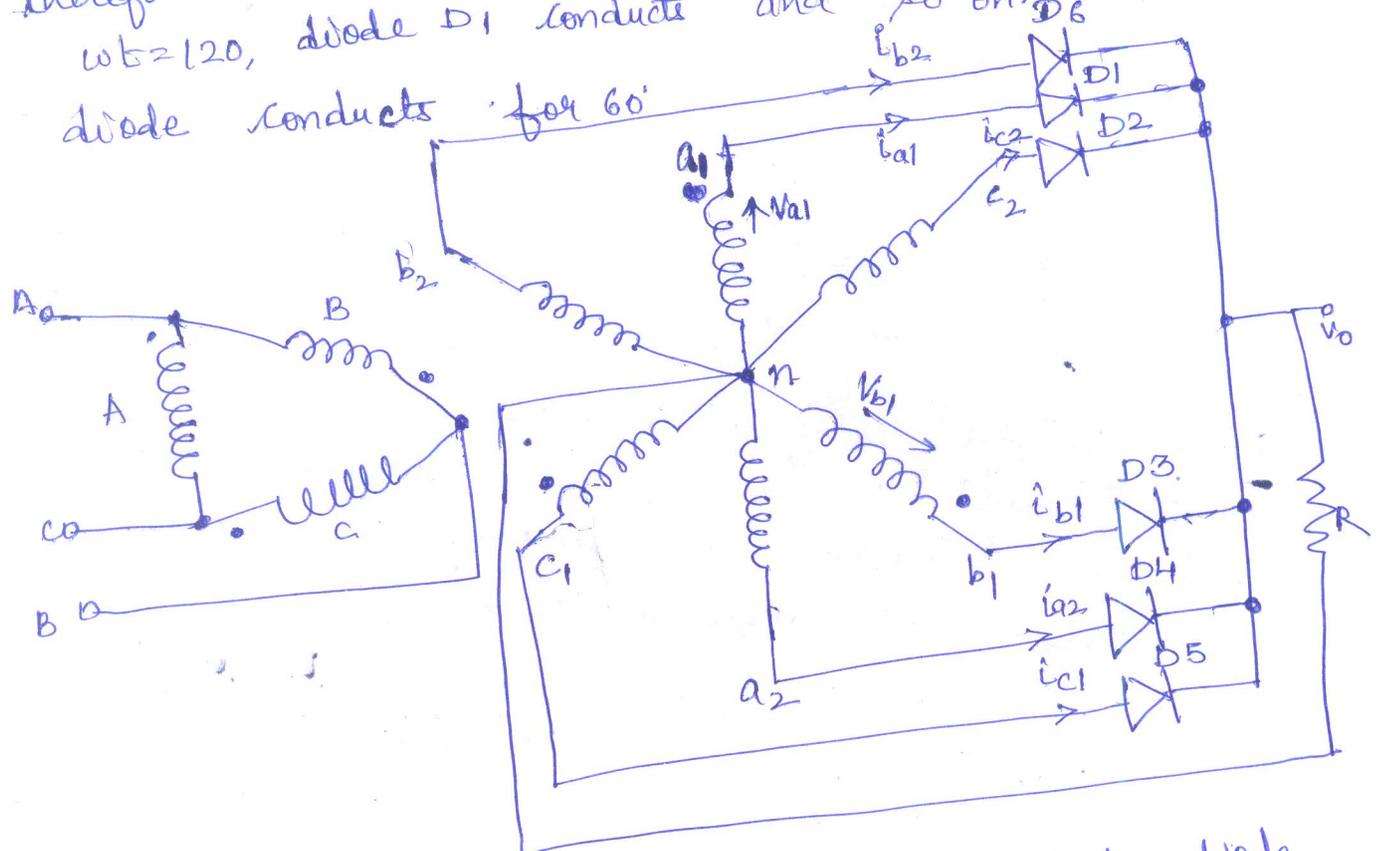
Therefore, if $V_{a1} = V_{mp} \sin \omega t$ then $V_{c2} = V_{mp} \sin(\omega t - 60^\circ)$
 $V_{b1} = V_{mp} \sin(\omega t - 120^\circ), V_{a2} = V_{mp} \sin(\omega t - 180^\circ) = -V_{a1}$

$$V_{c1} = V_{mp} \sin(\omega t - 240^\circ) = -V_{c2}$$

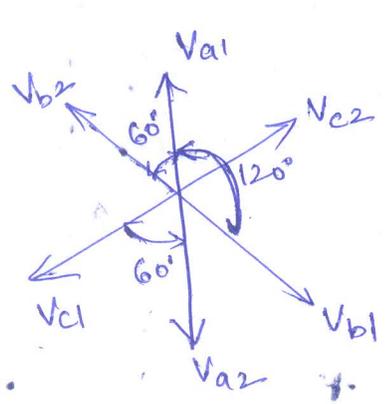
$$V_{b2} = V_{mp} \sin(\omega t - 300^\circ) = -V_{b1}$$

Here V_{mp} = maximum value of per phase voltage.

A diode sensing the highest positive mode potential gets forward biased and conducts. Therefore, from $\omega t = 0^\circ$ to $\omega t = 60^\circ$, voltage V_{b2} is the highest positive, therefore diode D_6 conducts; from $\omega t = 60^\circ$ to $\omega t = 120^\circ$, diode D_1 conducts and so on. Each diode conducts for 60°



Three phase mid point 6-pulse diode rectifier



Six phase voltage

5

Q.N.3 What are the principles and application of Induction heating? Explain.

Ans 3 In every transformer, there results the undesirable eddy current loss and means are adopted to reduce this loss. However, the same eddy-current loss may be effectively utilized for heating a metal piece during process of say forging. This constitutes the Induction heating.

Principle \rightarrow The a.c magnetic field produced by current i in the work coil passes through the metal object. Considering any closed metal path in the metal object through which flux ϕ passes, voltage induced in it by the magnetic flux is given by,

$$e = - \frac{d\phi}{dt}$$

The resulting a.c. eddy current flows in the conductor. Thus every closed path at right angles to the flux acts as a short circuited secondary with a definite resistance and inductance. This results in the production of heat in the metal object. Thus eddy currents produce heat through induction.

Application of induction heating \rightarrow (i) surface hardening of steel.

- (ii) Annealing of Brasses and Bronze items
- (iii) Brazing
- (iv) welding
- (v) drying paints on metals
- (vi) surgical instruments.