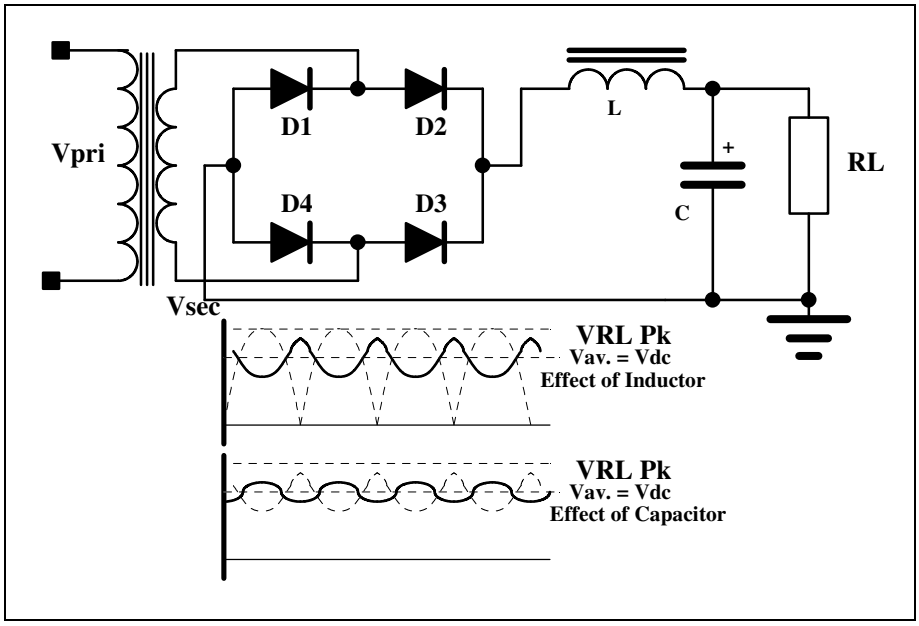
Filters and regulation

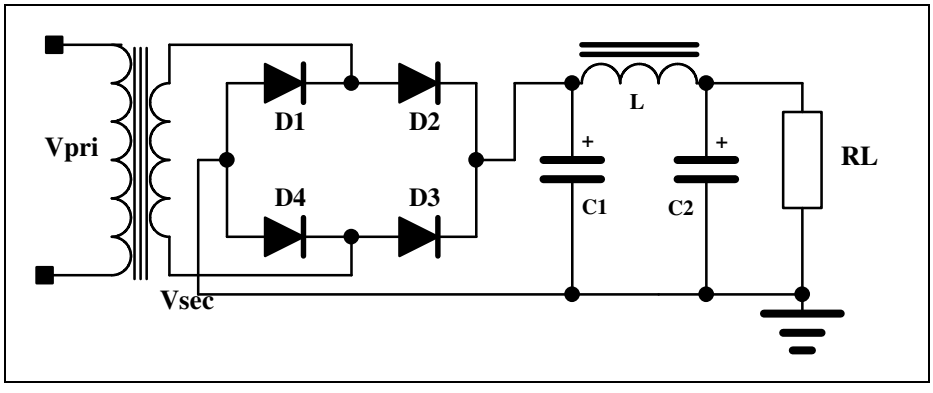
Inductive Filters

The capacitor input filter has the characteristic of increasing its 'sawtooth' like ripple with an increase in load current. (faster discharge of the filter capacitor between diode charging times) Early filter systems sometimes included an inductor to reduce this characteristic and was applied in two ways. The inductor was called a 'choke' and needed to be constructed of relatively large diameter wire wound around an iron core similar to power transformer construction and the dc load current complicated the design.

1. *Choke input filter* - The action of an inductor is to oppose any changes occurring due to the current through it and hence 'smooth out' the ripple produced in the rectification process. The diagram on the right illustrates the principle. The capacitor reduces the ripple much greater than shown. The average Vdc is about 0.63 X V_{RL}pk but tends to stay at this value for wide variations of the load current. The construction of the 'choke' is labour intensive and hence introduces a cost factor. The physical size of the choke must also be accommodated in the design of any equipment.



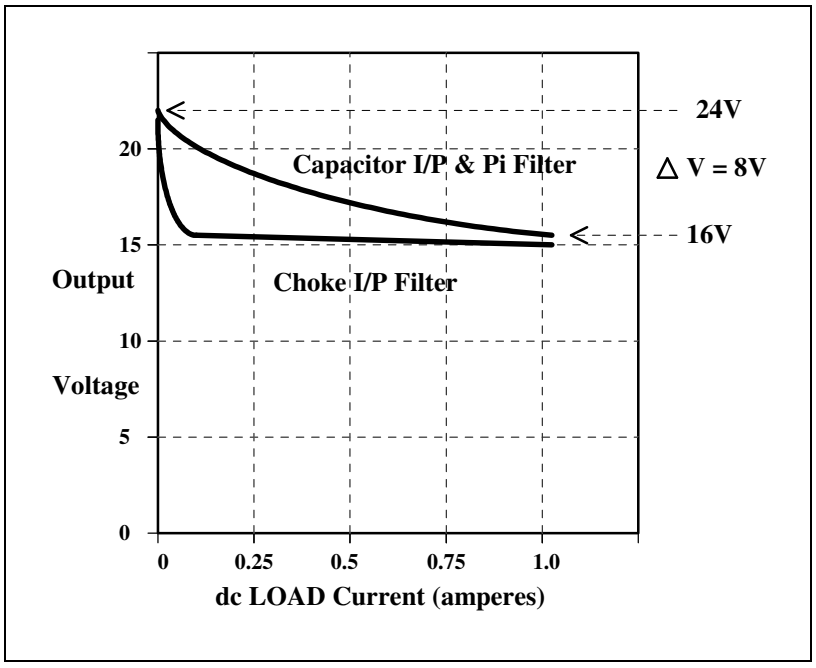
2. *Pi* (π) *filter* - By following a capacitor filter with a choke filter, a π filter is constructed which allows for a greater output voltage but with the advantage of much improved filtering of the ripple component of rectification. The diagram on the right shows the basic circuit. This type of filter was once very popular but is only found in old equipment due to the cost and physical bulk of the inductor. Both types of filter described above has



been replaced with electronic regulator circuits which both improve the steadiness of the output voltage and reduce the ripple component to very low proportions at a considerably reduced cost.

Load Regulation

As previously explained, the dc output voltage of a rectifier power supply will tend to reduce as the load current increases accompanied by an increase in the ripple amplitude. A typical curve showing the output dc voltage reduction against an increasing current is shown in the following diagram. The curve is typical for a transformer with an 18V secondary and a given sized filter capacitor. The change in output voltage is an indication of the 'regulation' of the power supply and is defined as



$$\%Reg. = \frac{V_{\text{No Load}} - V_{\text{Full Load}}}{V_{\text{Full Load}}} \times 100$$

For the curve shown

$$\%Reg. = \frac{24-16}{16} \times 100 = 50\%$$

The regulation is improved by using a larger filter capacitor and in typical rectifier supplies it is difficult to obtain a regulation of better than 15% without exceeding diode and transformer ratings. The diode must be able to handle the peak repetitive current as well as its average current rating. The peak repetitive current of a diode may be between 6 and 10 times its average current and hence it is not possible to increase the value of the filter capacitor without regard to this limitation. Any attempt to increase the filtering of a dc power supply by using increased values of filter capacitor will possibly lead to early failure of the rectifier diodes. The increase of peak current by increased filter capacitor value may also lead to local heating of the power transformer and elevated temperatures operation. The selection of transformer ratings were discussed in last lesson and due care should be taken if the transformer temperature rating is not to be exceeded.

Student problem

A bridge rectifier power supply with a capacitor filter was measured at 18V at zero load current and 15.5V with a load current of 500 mA.

Find i) % regulation ii) Value of the filter capacitor
iii) The voltage and approximate current rating of the transformer.