WHILE READING

Read “Classes of Amplifiers” below and look at the five figures on page 3. While reading, match each class of amplifier with its appropriate figure.
Put a number under each Figure from 1 to 5.

Classes of Amplifier

All amplifiers may be allocated to one of a number of classes depending on the way in which the active device is operated.

Class A

In class A amplifiers, the active device (for example, a bipolar transistor or a FET) conducts during the complete period of any input signal. An example of such a circuit would be a conventionally biased single-transistor amplifier of the type shown in **Figure 1**.

It can be shown that for conventional class A amplifiers, maximum efficiency is achieved for a sinusoidal input of maximum amplitude, when it reaches only 25%. With more representative inputs, the efficiency is very poor.

The efficiency of class A amplifiers may be improved by coupling the load using a transformer. The primary replaces the load resistor while the load is connected to the secondary to form a **transformer coupled amplifier**. This enables efficiencies approaching 50% to be achieved, but is unattractive because of the disadvantages associated with the use of inductive components, including their cost and *bulk*.

Class B

In a class B amplifier the output active devices conduct for only half the period of an input signal. These are normally push-pull arrangements in which each transistor is active for half of the input cycle. An example is given in **Figure 2**.

Class B operation has the advantage that no current flows through the output transistors in the quiescent state and so the overall efficiency of the system is much higher than in class A. If one assumes the use of ideal transistors, it can be shown that the maximum efficiency is about 78% .

Class AB

Class AB describes an amplifier that lies part way between classes A and B. The active device conducts for more than half of the input cycle but less than 100% . A class AB amplifier can be formed from a standard push-pull stage by ensuring that both devices conduct for part of the input waveform, as shown in **Figure 3**.

The efficiency of a class AB amplifier will lie between those of class A and class B designs, and will depend on the bias conditions of the circuit.

Class C

Following on from the definitions of classes A and B, it is perhaps not surprising that the definition of class C is that the active device conducts for less than half of the input cycle. Class C is used to enable the device to be operated at its peak current limit without exceeding its maximum power rating. The technique can produce efficiencies approaching 100%, but results in *gross distortion* of the waveform. For these reasons class C is used only in fairly specialized applications. One such use is in the output stage of radio transmitters where inductive filtering is used to remove the distortion. A possible circuit for a class C amplifier is given in **Figure 4**. Often the collector resistor in this figure is replaced by an RC tuned circuit.

Class D

In class D amplifiers, the active devices are used as switches and are either completely ON or completely OFF. A perfect switch has the characteristics of having infinite resistance when open and zero resistance when closed. If the devices used for the amplifier were perfect switches, this would result in no power being dissipated in the amplifier itself, since when a switch was ON it would have current flowing through it but no voltage across it, and when it was OFF it would have voltage across it but no current flowing through it. Since power is the product of voltage and current, the dissipation in both states would be zero. Although no real device is an ideal switch, bipolar transistors make very good switching devices and amplifiers based on power transistors are both efficient and *cost effective*. Amplifiers of this type are often called **switching amplifiers** or **switch mode amplifiers.**

Class D amplifiers may be single devices or push-pull pairs. In the latter case, only one of the two devices is ON at any time. An example of such an arrangement is shown in Figure 5.

Here a push-pull circuit is used to control a DC motor. An input voltage of Vcc turns the upper transistor OFF since it has zero volts between the base and the emitter. The lower transistor is driven hard on and, since it cannot draw current through the other transistor, pulls current from the motor. An input voltage of - V_{EE} has the opposite effect, turning the lower transistor OFF and the upper one ON. When the upper transistor is turned ON the motor is connected to the positive supply which will attempt to push current into the motor. When the lower transistor is ON, the motor is connected to the negative supply which will attempt to pull current from the motor. Since the motor has a considerable inductance, this will prevent the motor current from changing rapidly. If the input is switched rapidly between its two states, the output current will continuously *ramp up and down* in an attempt to respond to the changing voltages across it. If the *switching rate* is fast compared with the mechanical time constant (the rate of response) of the motor, it will respond simply to the *average* value of the switching waveform.

The diodes D1 and D2 are catch diodes, and are normally added to prevent damage to the transistors by the back EMF (ElectroMotive Force) from the motor. A practical implementation of this system would include a motor current sensing arrangement which would feed back the motor current to a "motor controller". The controller would then modify the times spent in each state to bring the average current to the desired value. This arrangement is considerably more complicated than a simple class A or B amplifier but has the advantage of greatly improved efficiency. In the case of ideal switches, the efficiency of the amplifier would be 100%.
In practice the transistors do dissipate some power, as do other circuit components required to control and stabilize the circuit. However, this method of power control is one of the most efficient

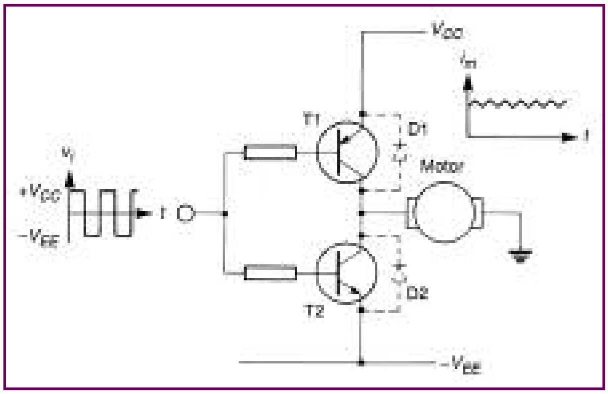
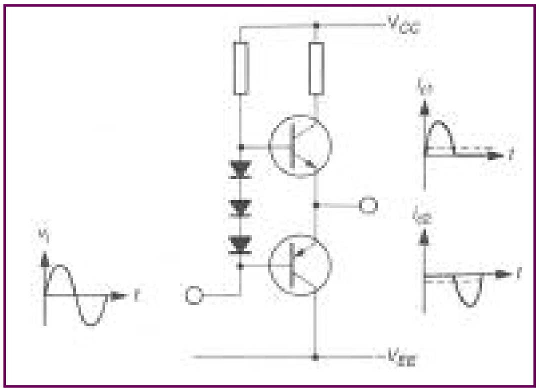


Figure: ....



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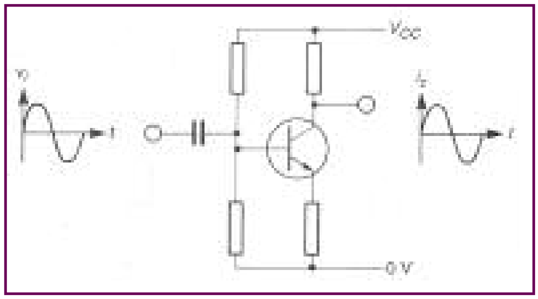
(from N. Storey, "*Electronics*")



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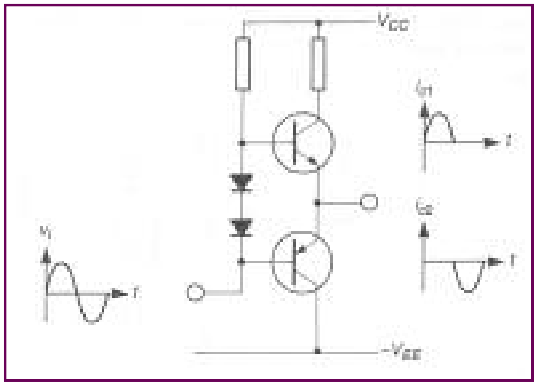

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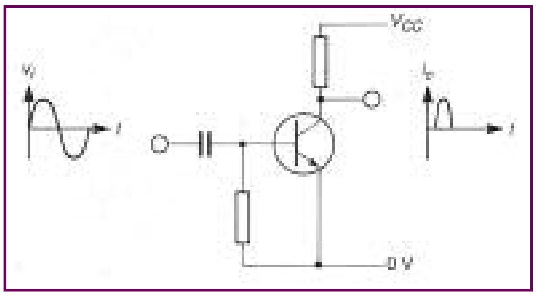

Figure: ....

techniques available.

AFTER READING

CONTENT

a. *Read the text again and for each class underline*:

- its distinguishable characteristic;
- its advantage over the other classes (if any);
- its disadvantage over the other classes (if any);
- its application(s).

b. *Read class D carefully again. Work in pairs and prepare an oral description of the figure showing a*