**Class D Amplifier :**

**Components used :**

* NE555 timer IC
* LM358 op-amp IC
* IRF540N
* Resistors: 1.8 kΩ, 1 kΩ, 100 Ω, 100 kΩ
* Capacitors: 1 nF, 10 nF, 470 nF (film), 470 µF electrolytic, 1 µF electrolytic
* Inductor: 100 µH, 2–3 A
* Speaker: 8 Ω (5–10 W speaker)
* Power: 12 V DC adapter

**Reasons for choosing Components :**

1. NE555 Timer (PWM Generator)

* Why chosen:
  + Simple, cheap, and easily available.
  + Can generate a stable square wave / triangle wave for PWM reference.
  + Beginner-friendly compared to making your own oscillator with transistors.
* Role in circuit:
  + Generates a high-frequency triangular/sawtooth waveform.
  + Used as a reference for the audio signal to create Pulse Width Modulation (PWM).

2. LM358 Op-Amp (Comparator)

* Why chosen:
  + Dual op-amp IC, cheap, widely used, works on single supply (5V–15V).
  + Available in almost every electronics lab.
* Role in circuit:
  + Compares the audio input with the triangular wave (from 555).
  + Converts the audio into PWM pulses.
  + This is the heart of a Class-D amplifier.

3. MOSFET (e.g., IRF540N / IRFZ44N)

* Why chosen:
  + High current handling → can drive a speaker easily.
  + Low Rds(on) → less heating, more efficiency.
  + Works fast enough to switch with PWM frequency.
* Role in circuit:
  + Acts as a switch.
  + The PWM signal from LM358 drives the MOSFET → amplifies the signal by switching power from supply to the load.

4. Inductor + Capacitor (LC Low-Pass Filter)

* Why chosen:
  + Standard and simplest way to remove high-frequency switching noise.
  + Inductor blocks high-frequency, passes audio. Capacitor smooths the output.
* Role in circuit:
  + Converts the MOSFET’s PWM pulses back into a clean audio signal.
  + Ensures only the amplified audio reaches the speaker, not the switching frequency.

5. Power Supply (12V Battery / DC Adapter)

* Why chosen:
  + Readily available and safe for small amplifiers.
  + Sufficient to power the MOSFET and op-amp.
* Role in circuit:
  + Provides energy that the MOSFET switches into the speaker.

**Working :**

The Class-D amplifier works by first converting the input audio signal into a series of high-frequency pulses before amplification. The small audio signal is compared with a triangular wave generated by a 555 timer circuit. This triangular wave acts as a carrier, and when the audio signal is greater than the triangle, the comparator (LM358) outputs a HIGH pulse, otherwise it outputs LOW. This process generates a Pulse Width Modulated (PWM) signal whose duty cycle varies according to the input audio. The PWM is then fed to a power MOSFET, which acts as a fast electronic switch, controlling a higher voltage supply. In this way, the weak audio signal modulates a strong power source. However, the MOSFET output is still in the form of high-frequency PWM, not smooth audio. To recover the original signal, an LC low-pass filter (inductor and capacitor) is used, which removes the switching frequency and allows only the audio frequencies to pass to the speaker. As a result, the speaker receives a clean, amplified version of the original input sound. This method makes the amplifier highly efficient, since the MOSFETs only switch fully ON or OFF, minimizing power loss and heat generation.