**EXP-1: Prompt Engineering**

**Aim**

To study and understand the **fundamentals of Generative AI** and **Large Language Models (LLMs)** by exploring their **foundational concepts, architectures (Transformers), applications, and the impact of scaling in LLMs.**

**Algorithm**

1. **Understand Generative AI Basics**
   * Define Generative AI and how it differs from traditional AI.
   * Learn how it creates new content (text, image, audio, video).
2. **Study Generative AI Architectures**
   * Focus on **Transformers** (attention mechanism, encoder-decoder).
   * Compare with earlier models (RNN, LSTM, GANs).
3. **Explore Applications of Generative AI**
   * Content creation, chatbots, image generation, drug discovery, coding assistants, etc.
4. **Analyze the Impact of Scaling in LLMs**
   * Relationship between **parameters, data, compute → performance**.
   * Emergence of new abilities with scaling (e.g., reasoning, multi-tasking).
5. **Summarize Findings**
   * Present a structured explanation of concepts with examples.

**Output**

**1. Foundational Concepts of Generative AI**

* Generative AI focuses on **creating new data** that resembles existing patterns.
* Unlike discriminative models (which classify), generative models **generate** text, images, or audio.
* Example: ChatGPT generates human-like text responses.

**2. Generative AI Architectures**

* **Early Models:** RNNs, LSTMs → sequence processing, but suffered from long-term memory issues.
* **GANs (Generative Adversarial Networks):** Used for realistic image generation.
* **Transformers (Key Architecture):**
  + Introduced in “Attention is All You Need” (2017).
  + Uses **self-attention mechanism** to capture relationships between words.
  + Scales efficiently with parallel processing.
  + Backbone of modern LLMs (GPT, BERT, LLaMA).

**3. Applications of Generative AI**

* **Text Generation:** ChatGPT, content writing, summarization.
* **Image Generation:** DALL·E, Stable Diffusion, MidJourney.
* **Healthcare:** Drug discovery, protein folding (AlphaFold).
* **Coding:** GitHub Copilot, AI pair programmers.
* **Business:** Virtual assistants, marketing content, customer support.
* **Education:** Personalized tutoring, question-answering systems.

**4. Impact of Scaling in LLMs**

* **Scaling Laws:** As model size (parameters) and training data grow, performance improves predictably.
* **Emergent Abilities:** Larger LLMs show unexpected skills (translation, reasoning, coding).
* **Trade-offs:** High computational cost, energy usage, ethical risks (bias, misinformation).
* **Current Trend:** From billions → trillions of parameters (GPT-4, LLaMA 3).

**Result**

* Successfully studied the **fundamental concepts of Generative AI**.
* Understood the **importance of Transformers** in powering modern LLMs.
* Learned about **real-world applications** across industries.
* Analyzed the **impact of scaling**, showing how bigger models unlock advanced capabilities but also raise challenges.

**Conclusion:** Generative AI and LLMs are revolutionizing industries with creative automation, problem-solving, and human-like interaction. Their future depends on responsible scaling and ethical use.