Science & Technology · GS - III

Examine how the combination of specialised hardware, software ecosystems and economies of scale has shaped market concentration in the global AI semiconductor industry. What challenges does this pose for India's technological self-reliance?

EXAM YEAR	PAPER	SUBJECT
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MARKS	WORD LIMIT
10	~150 words

Answer Hint

AI accelerators, GPUs, CUDA ecosystem, parallel computing, network effects, economies of scale, semiconductor supply chains, technological dependence, design capabilities, fabrication infrastructure, India Semiconductor Mission, research and development.

Model Answer

Introduction

The rapid expansion of artificial intelligence has increased demand for specialised computing hardware. Companies combining advanced processors with integrated software ecosystems have acquired significant competitive advantages in this market.

Factors Driving Market Concentration

- **Hardware capabilities:** GPUs enable parallel processing essential for training large AI models.
- **Software ecosystems:** Platforms such as CUDA provide developers with established tools, libraries and programming environments, increasing switching costs.

- **Economies of scale:** Large research investments, manufacturing partnerships and global distribution networks strengthen established players.
- **Network effects:** A wider developer ecosystem encourages further adoption of compatible hardware.

Challenges for India

Dependence on imported accelerators exposes India to supply-chain disruptions, geopolitical restrictions and high computing costs. Limited advanced fabrication capacity and insufficient domestic intellectual property also constrain competitiveness.

Way Forward

India should strengthen semiconductor design, fabrication and advanced packaging capabilities. Greater investment in research, university-industry collaboration, indigenous AI accelerators and open software ecosystems can reduce technological dependence.

Conclusion

Technological self-reliance requires more than domestic chip manufacturing. India must develop an integrated ecosystem spanning hardware, software, skilled manpower and innovation.

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