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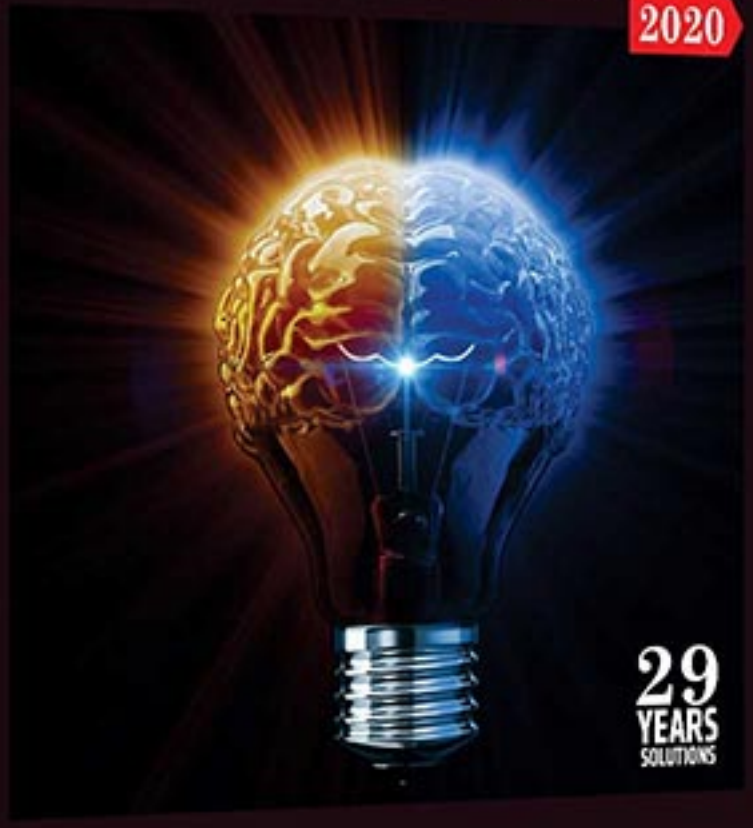

29
YEARS
SOLUTIONS

ELECTRICAL ENGINEERING GATE-2020

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GATE SOLUTIONS
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PREFACE

The Graduate Aptitude Test in Engineering (GATE) is an All-India examination administered and conducted in eight zones across the country by the GATE Committee comprising of Faculty members from IISc, Bangalore and other seven IITs on behalf of the National Coordinating Board, Department of Education, Ministry of Human Resources Development.

The GATE score/rank is used for admissions to Post Graduate Programmes (ME, M.Tech, MS, direct PhD) in institutes like IIT and IISc, etc. with financial assistance offered by the Ministry of Human Resource Development. PSUs too use the GATE scores for recruiting candidates for various prestigious jobs with attractive remuneration.

The door to GATE exam is through previous year question papers. If you are able to solve question papers in access of 10 years, you are sure to clear the GATE exam, and open new vistas of career and learning.

The **Electrical Engineering GATE 2020** book from IES Master offers detailed topic-wise solutions for the past 29 years question papers. The emphasis is clearly on the understanding of concepts and building upon a holistic picture. So as you finish a topic, for instance, Power System Stability, you will find all the previous years' question papers with detailed explanation under that particular topic.

The approach has been to provide explanation in such a way that just by going through the solutions, students will be able to understand the basic concepts and will apply these concepts in solving other questions that might be asked in future exams.

Every care has been taken to bring an error-free book. However, comments, suggestions, and feedback for improvement in the future editions are most welcome.

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CONTENT

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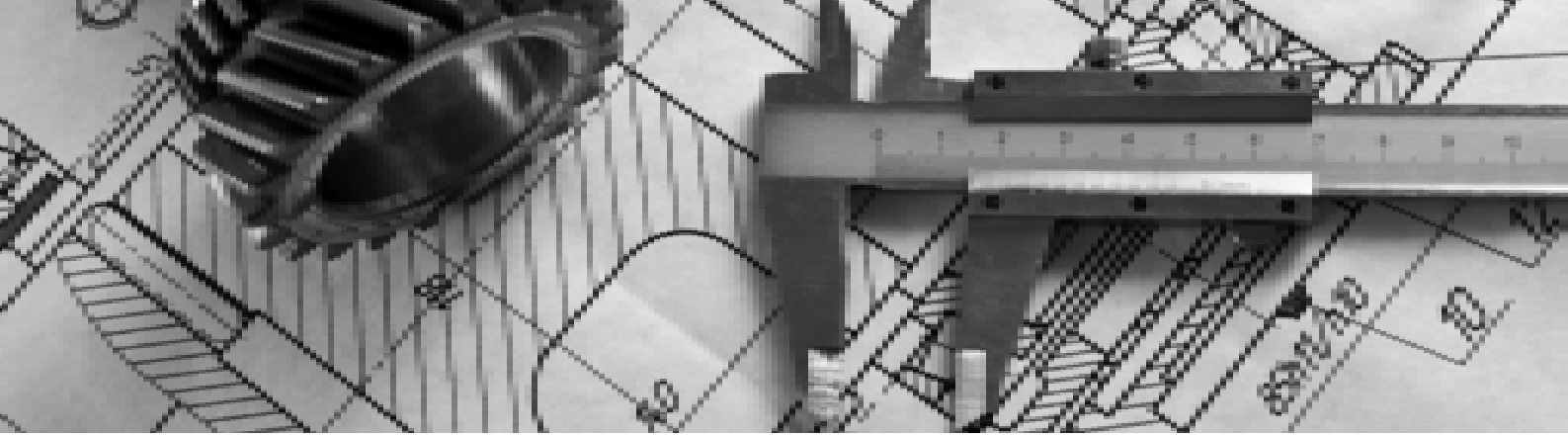

UNIT-1 POWER SYSTEMS

SYLLABUS

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss Seidel and Newton-Raphson load flow methods, Voltage and frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area crterion.

CONTENTS

1 GENERATING POWER STATIONS AND PER UNIT SYSTEM

1– Mark

1. A 500 MVA, 11 KV synchronous generator has 0.2 p.u. synchronous reactance. The p.u. synchronous reactance on the base values of 100 MVA and 22 KV is

(a) 0.16 (b) 0.01

(c) 4.0 (d) 0.25 ***[GATE-1991]***

2. In order to have a lower cost of electrical energy generation

(a) The load factor and diversity factor should be low

(b) The load factor should be low but diversity factor should be high

(c) The load factor should be high but diversity factor should be low

(d) The load factor and diversity factor should be high. ***[GATE-1995]***

3. Which material is used in controlling chain reaction in a nuclear reactor?

(a) Thorium

(b) Heavy water

(c) Boron

(d) Beryllium

[GATE-1996]

4. In a thermal power plant, the feed water coming to the economiser is heated using

(a) H.P. Steam

(b) L.P. Steam

(c) Direct heat in the furnace

(d) Flue gases ***[GATE-2000]***

5. The rated voltage of a 3-phase power system is given as

(a) rms phase voltage

(b) peak phase voltage

(c) rms line to line voltage

(d) peak line to line voltage. ***[GATE-2004]***

6. In thermal power plants, the pressure in the working fluid cycle is developed by

(a) condenser (b) super heater

(c) feed water pump (d) turbine

[GATE-2004]

7. For harnessing low variable waterheads, the suitable hydraulic turbine with high percentage of reaction and runner adjustable vanes is

(a) Kaplan (b) Francis

(c) Pelton (d) Impeller

[GATE-2004]

8. Out of the following plant categories :

(i) Nuclear (ii) Run-off-river

(iii) Pump Storage (iv) Diesel

The base load power plants are

(a) (i) and (ii) (b) (ii) and (iii)

(c) (i), (ii) and (iv) (d) (i), (iii) and (iv)

[GATE-2009]

9. A three phase star-connected load is drawing power at a voltage of 0.9 pu and 0.8 power factor lagging. The three phase base power and base current are 100 MVA and 437.38A respectively. The line-to-line load voltage in kV is _____. ***[GATE-2014]***

10. Base load power plants are

P: wind farms

Q: run-off-river plants

R: nuclear power plants

S: diesel power plants

Choose the correct answer :

(a) P, Q and S only (b) P, R and S only

(c) P, Q and R only (d) Q and R only

[GATE-2015]

2– Marks

1. The synchronous reactance of a 200 MVA, 10kV, 3-phase, 50 Hz generator is 1.0 p.u. at its own

ANSWER KEY

:: 1 MARK ::

1. (b)
2. (d)
3. (c)
4. (d)
5. (c)
6. (c)
7. (a)
8. (a)
9. (118.8)
10. (d)

:: 2 MARKS ::

1. (0.125)
2. (c)
3. (b)
4. (d)
5. (d)
6. (b)
7. (b)

EXPLANATIONS

1– Mark

Sol–1: (b)

$$Z(p.u.)_{new} = Z(p.u.)_{old} \times \left(\frac{kV_{old}}{kV_{new}}\right)^2 \times \left(\frac{MVA_{new}}{MVA_{old}}\right)$$

$$= 0.2 \times \left(\frac{11}{22}\right)^2 \times \frac{100}{500}$$

$$= \frac{0.2}{20} = 0.01$$

Sol–2: (d)

$$\text{Load factor} = \frac{\text{Average load}}{\text{Peak load}}$$

The cost of production depends upon two factors-fixed and variable cost. High load factor means fixed costs are spread over more kWh of output.

$$\text{Fixed cost per kWh}(\downarrow) = \frac{\text{Fixed Cost}}{\text{Generated energy}(\uparrow)}$$

$$\text{Group divesity factor} = \frac{\text{Sum of individual maximum demand}}{\text{Maximum demand of the group}}$$

A large diversity factor has the effect of reducing maximum demand on the plant. So lesser plant capacity is required. Thus, the capital investment on the plant is reduced, and the cost of generation is also reduced.

Sol–3: (c)

- Control rods are used to control the chain reaction in a nuclear reactor. The control rods are made up of materials having high absorption cross section. Such materials are Boron, Hafnium and Cadmium.
- Thorium is used as a fuel in nuclear power plant.
- Heavy water is used as a moderator to slow down neutrons in a nuclear reactor, so that they are more likely to react with fissile material.
- Beryllium has low thermal neutron absorption cross section, hence it is used as a reflector in nuclear reactors to prevent neutrons from escaping.

Sol–4: (d)

Flue gases coming out of the boilers carry lot of heat. An economiser extracts a part of this heat from the flue gases and uses it for heating feed water.

Sol–5: (c)

The rated voltage of a 3-phase power system is always rms line to line voltage.

Sol–6: (c)

- In a thermal power plant, the feed water pump is used to pump feed water into a steam boiler. The feed water pump is used to generate sufficient pressure, so that the steam pressure developed by the boiler can be overcome.
- Condenser is used to condense the exhaust stream from a steam turbine to obtain maximum efficiency.
- Superheater converts wet steam to superheated / dry steam with the half of thermal energy of flue gases.

Sol–7: (a)

- Propeller turbine is a reaction turbine suitable for low head and large quantity of water. It is suitable for heads below 30m.
- A Kaplan turbine is a propeller turbine with adjustable blades, the advantage of