

**III B.Tech. I Semester Supplementary Examinations, May -2005**

**ELECTROMECHANICS-III**

**(Electrical & Electronic Engineering)**

**Time: 3 hours**

**Max Marks: 80**

**Answer any FIVE Questions  
All Questions carry equal marks**

\*\*\*\*\*

1. (a) What is a fractional pitch winding  
(b) Calculate the distribution factor for a single phase alternator having 6 slots/pole,
  - i. when all the slots are wound and
  - ii. When only four adjacent slots/pole are wound and the remaining being not wound.
2. (a) What is armature reaction? Explain the effect of armature reaction on the terminal voltage of an alternator at
  - i. Unity power factor load
  - ii. Zero lagging pf load and
  - iii. Zero leading pf load. Draw the relevant phasor diagram.(b) A 3-phase, 50HZ, 8-pole alternator has a star connected winding with 120 slots and 8 conductors per slot. The flux per pole is 0.05Wb, Sinusoidally distributed. Determine the phase and line voltages.
3. (a) What is voltage regulation? Discuss the synchronous impedance method of calculating voltage regulation.  
(b) A 500V, 50KVA, 1-phase alternator has an effective resistance of  $0.2\Omega$ . A field current of 10A produces an armature current of 200A on short circuit and an emf of 450V on open circuit. Calculate
  - i. Synchronous impedance and reactance
  - ii. Full-load regulation with 0.8p.f. lagging.
4. (a) Describe the slip test method for the measurement of  $X_d$  to  $X_q$  of synchronous Machines.  
(b) A 3.5 MVA, slow-speed, 3-phase synchronous generator rated at 6.6KV has 32 poles its direct - and quadrature - axis synchronous reactances as measured by the slip test are  $9.6\Omega$  and  $6\Omega$  respectively. Neglecting armature, determine the regulation and the excitation emf needed to maintain 6.6KV at the terminals when supplying a load of 2.5MW at 0.8pf lagging. What maximum power can the generator supply at the rated terminal voltage, if the field becomes open-circuited?
5. (a) Derive the expressions for load sharing between the dissimilar alternators.

- (b) Two identical 2000KVA alternators operate in parallel. The governor of first machine is such that the frequency drops uniformly from 50HZ on no load to 48Hz on full load. The corresponding uniform speed drop of the second machine is 50 Hz to 47.5 Hz.
- How will the two machines share a load of 3000 Kw?
  - What is the maximum load at unity power factor that can be delivered without over loading either machine?
6. (a) What are the advantages and disadvantages of the synchronous motor?
- (b) A Synchronous motor takes 25KW from 400V supply mains. The synchronous reactance of the motor is  $4\Omega$ . Find the power factor at which the motor would operate when the exciting current is so adjusted that the generated emf is 500V.
7. (a) Explain the power circle diagrams of the synchronous motor.
- (b) A 400V, 3 phase, Y connected synchronous motor takes 3.73Kw at normal voltage and has an impedance of  $(1+j8)\Omega$  per phase. Calculate the current and pf if the induced emf is 460V.
8. (a) Describe the slip-torque characteristics of a single phase induction motor.
- (b) A laboratory test on a single-phase induction motor has given the following data with rotational losses being equal to 17W.  
Block rotor test:  $V_{sc}= 110V$ ,  $I_{sc}=14.8A$  and  $P_{sc}=1130W$   
No load test:  $V_o=110V$ ,  $I_o= 2.8A$  and  $P_o=60W$   
Determine the parameters of the equivalent circuit and the core loss.

\*\*\*\*\*

**III B.Tech. I Semester Supplementary Examinations, May -2005****ELECTROMECHANICS-III****(Electrical & Electronic Engineering)****Time: 3 hours****Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

\*\*\*\*\*

1. (a) Derive the expressions for distribution and pitch factors  
(b) Calculate the distribution factor of a 3-phase winding with  $120^\circ$  phase spread when the winding is
  - i. Uniformly distributed,
  - ii. occupies 6 slots per pole.
2. (a) Derive emf equation for an alternator from fundamentals.  
(b) A 50Hz alternator has a flux of 0.1 wb/pole, sinusoid ally distributed. Calculate the rms value of the emf generated in one turn of the winding, which spans  $\frac{3}{4}$  of a pole pitch.
3. (a) What is voltage regulation? Discuss the synchronous impedance method of calculating voltage regulation.  
(b) A 500V, 50KVA, 1-phase alternator has an effective resistance of  $0.2\Omega$ . A field current of 10A produces an armature current of 200A on short circuit and an emf of 450V on open circuit. Calculate
  - i. Synchronous impedance and reactance
  - ii. Full-load regulation with 0.8p.f. lagging.
4. (a) What conditions must be fulfilled before an alternator can be connected to an infinite bus?  
(b) Calculate the synchronizing torque for unit mechanical angle of phase displacement for a 5000KVA, 3- phase alternator running at 1500 rpm when connected to 6600 volt. 50 Hz , bus-bars. The armature has a short circuit reactance of 15%.
5. (a) Explain the procedure to determine the following
  - i. Sub transient reactance
  - ii. Transient reactance
  - iii. Steady state reactance  
(b) The speed regulation of two 500 KW alternators A and B running in parallel are 100% to 104% and 100% to 105% from full load to no load respectively. How will the two alternators share a load of 800KW and also find the load at which one machine ceases to supply any portion of the load?

6. (a) Describe briefly the effect of varying excitation upon the armature current and power factor of a synchronous motor when input power to the motor is maintained constant.
- (b) A 400V, 50Hz, 37.3KW 3-phase star connected synchronous motor has a full load efficiency of 88%. The synchronous impedance of the motor is  $(0.2+j1.6)\Omega$  per phase. If the excitation of the motor is adjusted to give a leading power factor of 0.9 calculate for full load
- i. the induced emf
  - ii. the total mechanical power developed.
7. (a) Explain the excitation circles of synchronous motor.
- (b) A 5000KVA, 10KV, 1500 rpm, 50HZ alternator runs in parallel with other machines. Its synchronous reactance is 20%. Find the synchronizing power per unit mechanical angle of the phase displacement for
- i. No load and
  - ii. Full load at 0.8pf (lag)
- Also calculate the synchronizing torque if the mechanical displacement is  $0.5^\circ$ .
8. (a) Explain the operating characteristics of AC series motor.
- (b) A 220V, 500W, 50Hz series motor has a total resistance of 2 ohm and total reactance of 20 ohm. The full load stray losses and speed are 40W and 500rpm. Determine the current taken by the motor and power factor at rated load.

\*\*\*\*\*

**III B.Tech. I Semester Supplementary Examinations, May -2005****ELECTROMECHANICS-III****(Electrical & Electronic Engineering)****Time: 3 hours****Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

\*\*\*\*\*

1. (a) What are the causes of harmonics in the voltage and current waveforms of electrical machinery and what means are taken in design to reduce them?  
(b) Find the value of Kd for an alternator with 9 slots per pole for the following cases.
  - i. one winding in all the slots
  - ii. one winding using only the first 2/3 of the slots/pole
  - iii. three equal windings placed sequentially in  $60^\circ$  group.
2. (a) Draw and explain the phasor diagram of an alternator at lagging power factor  
(b) A 6-pole alternator rotating at 1000 r.p.m has a single-phase winding housed in 3 slots per pole, the slots in groups of three being  $20^\circ$  apart. If each slot contains 10 conductors, and the flux per pole is  $2 \times 10^{-2}$  Wb, Calculate the voltage generated, assuming the flux distribution to be sinusoidal.
3. (a) What is voltage regulation? Discuss the synchronous impedance method of calculating voltage regulation.  
(b) A 500V, 50KVA, 1-phase alternator has an effective resistance of  $0.2\Omega$ . A field current of 10A produces an armature current of 200A on short circuit and an emf of 450V on open circuit. Calculate
  - i. Synchronous impedance and reactance
  - ii. Full-load regulation with 0.8p.f. lagging.
4. (a) Explain the terms direct - axis synchronous reactance and quadrature - axis Synchronous reactance of a salient - pole alternator. On what factors do these values depend?  
(b) A 3 MVA , 6- Pole alternator runs at 1000 rpm in parallel with other machines on 3.3KV bus bars .The synchronous reactance is 20% . calculate the synchronizing power per one mechanical degree of displacement and the corresponding synchronizing torque when the alternator as supplying full load at 0.8 lag p.f.
5. (a) Explain the necessity of parallel operation of alternators.  
(b) Two 50MVA, 3-phase alternators operate in parallel. The settings of the governors are such that the rise in speed from full-load to no-load in 2% in one machine and 3% in the other, the characteristics being straight lines in both cases. If each machine is fully loaded when the total load is 100MW, what will be the load on each machine when the total load reduced 60MW?

6. (a) What are the applications of synchronous motor?
- (b) A 2,000V, 3-phase star connected synchronous motor has an effective resistance and synchronous reactance of  $0.2\Omega$  and  $2.2\Omega$  respectively. The input is 800KW at normal voltage and the induced line emf is 2500V. Calculate the line current and power factor.
7. (a) What could be the reasons if a synchronous motor fails to start?
- (b) The synchronous reactance per phase of a 3-phase star connected 6600V synchronous motor is  $10\Omega$ . For a certain load, the input is 900KW and the induced line emf is 8900V(line value). Evaluate the line current. Neglect resistance.
8. (a) Explain the principle of operation and constructional features of a single phase induction motor.
- (b) A 110V, 6 pole, 50Hz, single winding single phase induction motor has the following equivalent circuit parameters as referred to the stator  
 $r_1 = 1.5\Omega$   $x_1 = 2.5\Omega$   $r_2 = 0.75\Omega$   $x_2 = 1.0\Omega$ .  
Neglecting the magnetizing current, estimate the following when the motor is running at a slip of 3%.
- i. the ratio ( $E_{sf}/E_{sb}$ )
  - ii. the ratio ( $V_f/V_b$ )
  - iii. the ratio ( $T_f/T_b$ ) and
  - iv. the gross total torque.

★ ★ ★ ★ ★

**III B.Tech. I Semester Supplementary Examinations, May -2005****ELECTROMECHANICS-III****(Electrical & Electronic Engineering)****Time: 3 hours****Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

\*\*\*\*\*

1. (a) Explain the effect of harmonics on pitch and distribution factors.  
(b) An alternator has 18 slots/pole and the first coil lies in slots 1 and 16. Calculate the pitch factor for
  - i. Fundamental
  - ii. 3<sup>rd</sup> harmonics
  - iii. 5<sup>th</sup> harmonics and
  - iv. 7<sup>th</sup> harmonics.
2. (a) What do you mean by synchronous reactance? Explain the term synchronous impedance of an alternator.  
(b) Calculate the speed and open - circuit line and phase voltages of a 4-pole, 3-phase, 50HZ, star-connected alternator with 36 slots and 30 conductors per slot. The flux per pole is 0.0496 Wb and is sinusoidally distributed.
3. (a) What is voltage regulation? Discuss the synchronous impedance method of calculating voltage regulation.  
(b) A 500V, 50KVA, 1-phase alternator has an effective resistance of  $0.2\Omega$ . A field current of 10A produces an armature current of 200A on short circuit and an emf of 450V on open circuit. Calculate
  - i. Synchronous impedance and reactance
  - ii. Full-load regulation with 0.8p.f. lagging.
4. (a) A 3 MVA, 6-pole alternator runs at 1000 r.p.m in parallel with other machines on 3.3 KV bus-bars. The synchronous reactance is 20%. Calculate the synchronizing power per one mechanical degree of displacement and the corresponding synchronizing torque.
5. (a) Derive the expressions for load sharing between the dissimilar alternators.  
(b) Two similar 13,000V, 3- phase alternators are operated in parallel on infinite bus-bars. Each machine has an effective resistance and reactance of  $0.05\Omega$  and  $0.5\Omega$  respectively. When equally excited, they share equally a total load of 18Mw at 0.8 power factor lagging .If the excitation of one generator is adjusted until the armature current is 400A. and the steam supply to its turbine remains unaltered, find the armature current, the e.m.f and the power factor of the other generator.
6. (a) Explain synchronous motor ratings?

- (b) A 3-phase, star connected synchronous motor has a synchronous reactance of  $4\ \Omega$  per phase and is working on 1100V. Calculate the power factor of the machine when taking 90KW from the mains. The excitation being adjusted to a value corresponding to an induced emf of 1200V. Neglect armature resistance?
7. (a) What are the uses of damper windings in a synchronous motor?  
(b) Why it is necessary to increase the excitation to obtain minimum current with the application of load.
8. (a) Explain the operating characteristics of AC series motor.  
(b) A 220V, 500W, 50Hz series motor has a total resistance of 2 ohm and total reactance of 20 ohm. The full load stray losses and speed are 40W and 500rpm. Determine the current taken by the motor and power factor at rated load.

\*\*\*\*\*