**SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING**

FNU FIJI NATIONAL UNIVERSITY

**COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY**

**CERTIFICATE IN ELECTRICAL SERVICEMAN'S COURSE – STAGE 2**

**EEE 221 APPLIED ELECTRICITY 2**

**FINAL EXAMINATION SOLUTIONS – PENSTER 2 [2014]**

# SOLUTIONS

ESC 2, EEE 221 - APPLIED ELECTRCITY 2 EXAM PAPER, PENSTER 2 [2014]
SECTION A (20 MARKS) MULTIPLE CHOICE.

**ANSWERS:**

**Q 1** Ans: (A) $I_N = -(iR + iW + iB)$ (1 mark)

**Q 2** Ans: (D) Motor stops (1mark)

**Q 3** Ans: (D) Run windings are connected in parallel with the start windings, the centrifugal switch and the capacitor are connected in series with the start windings. (1 mark)

**Q 4** Ans: (C) 144 V

Calculation: (DELTA 1) $V_L = V_p = 415\ \ (= V1)$

$$V2 = V1 \times \frac{N2}{N1} = 415 \times 60/300$$

$$= 83\ V\ (= Vp)$$

(STAR 2) $VL = \sqrt{3}.Vp$

$$= \sqrt{3} \times 83V$$

$$\boldsymbol{Vout = 144\ V}$$ (1mark)

**Q 5** Ans: (A) Equal voltages, same phase shifts and sequence can be connected In parallel. (1 mark)

**Q 6** Ans: (B) $\boldsymbol{\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}}$ (1 mark)

**Q 7** Ans: (D) Run windings – heavy gauge wire and more turns, start windings – Fine gauge wire and less turns. (1 mark)

**Q 8** Ans: (D) Total power= $3V_L \frac{I_L}{\sqrt{3}} \cos \emptyset$

$$= \boldsymbol{\sqrt{3} V_L I_L \cos} \emptyset$$ (1 mark)

**Q9.** Ans: (C) 3000 r. p. m.

Calculation: $n_{syn} = {}^{120f}/_{P}$

$= {}^{120 \times 50}/_{2}$

$\boldsymbol{n_{syn} = 3000\, r.p.m.}$ (1 mark)

**Q10.** Ans: (C) star connected only (1 mark)

**Q 11.** Ans: (D) none (1 mark)

**Q12.** Ans: (A) single phase motors (1 mark)

**Q13.** Ans: (B) 6 poles (1 mark)

**Q14.** Ans: (C) 120° (1 mark)

**Q15.** Ans: (A) zero (1 mark)

**Q16.** Ans: (C) 2 Hz (1 mark)

**Q17.** Ans: (A) All turns are equally insulated (1 mark)

**Q18.** Ans: (C) cool the winding (1 mark)

**Q19.** Ans: (C) it reduces voltage per coil (1 mark)

**Q20.** Ans: (D) is 90 -98 % (1 mark)

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**SECTION B** (30 MARKS) BRIEF ANSWERS.

**ANSWERS:**

1 The value of the neutral current of any three phase, four wire system is equal to minus the phasor sum of the line currents.
$I_N = -(iR + iW + iB)$ (2 marks)

2 a) Same current loading on each phase (1 mark)
b) Each current must have the same power factor (1 mark)

3 STAR (4 marks) DELTA (4 marks)

| STAR (4 marks) | | DELTA (4 marks) | |
|---|---|---|---|
| a. Similar ends connected together | (1) | a. Dissimilar ends connected | (1) |

| | | | |
|---|---|---|---|
| b. For balanced loads | (1) | b. For balanced loads | (1) |
| $V_L = \sqrt{3V_p}$ | (1) | $V_L = V_p$ | (1) |
| $I_L = I_p$ | (1) | $I_L = \sqrt{3I_p}$ | (1) |
| c. Two voltages available | (1) | c. One voltage only | (1) |
| d. $V_L = leads\ V_p\ by\ 30°\ E$ | (1) | d. $I_L = leads\ I_p\ by\ 30°\ E$ | (1) |
| e. Has central connection for earthing | (1) | e. No central earthing connection | (1) |
| f. Suited for long-distance power transmission | (1) | f. Suited for localized rotating machinery | (1) |

4 Laminated stator core is made up of sheet steel punching's with slots in the inner surface.
Windings consists of three identical windings the same alternators and synchronous motor. (3 marks)

5. It consists of a shaft with bearings, laminated iron core, and rotor conductors. The most common type construction is that with rotor bars in laminated slots in place of windings.

Rotor bars, short circuited at each end by solid rings and for small motors they are casted in one piece out of aluminum.
(3 marks)

6 (a) Run windings:

- connected in series and displaced around the stator to form a set number of poles.
- Wound with heavier gauge wire to reduce its resistance.
- Imbedded deep into the slots of the iron core to increase inductance.
- Have more turns than the starting winding. (2 marks)

6 (b) Start windings:

- connected in series and displaced around the stator to form a set number of poles.
- It will have equal number of poles as the run windings
- Displaced 90° E around the stator core
- Coils are wound with fewer turns with fine gauge wire.
- Placed near the surface of the slot of the stator reducing the
- Inductance of the windings. (2 marks)

7.a. **Equal voltages:**

- If two unequal voltage sources connected together in parallel circulating currents is set up between the two sources.
- Each transformer becomes a burden on one another and they are unable to supply power to the external load. (2 marks)

7.b. **Same phase sequence:**

- Different phase sequence connected together in parallel will cause short circuit between the lines.
- Heavy circulating currents flow and cause damage to the section of the installation. (2 marks)

7.c. **Phase voltage to be in step:**

- Transformers to be in parallel should belong to the same group.
- Must have the same phase shift
- Not in the same group will cause heavy damage to both transformers and impose heavy drain on the supply. (2 marks)

8. The rectifying unit can be viewed as a one way valve, it allows current to flow through it in one direction but not in the other. (2 marks)

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SECTION C (50 MARKS) CALCULATIONS

**ANSWERS:**

1. In general approximation, to reduce the voltage excursions of rectifier output to a practical value it is usual to take $\frac{1}{10}$ of the load resistance in ohms and use this figure as a capacitive reactance of the capacitor filter.

$Xc = \frac{150}{10} = 15\Omega$

$C = \frac{1}{2\pi f Xc}$

$= 10^6/2 \times \pi \times 50 \times 15$

$\underline{= 212\ \mu F}$ (5 marks)

2.a. $s = \frac{n_{syn-n}}{n_{syn}} \times 100$ $[n_{syn} = {}^{120f}/_{P}]$

$s = \frac{1500-1450}{1500} \times 100 = 3.3\%$ (2 marks)

$fr = {}^{s.f}/_{100}$

$fr = {}^{3.3 \times 50}/_{100}$

$\underline{fr = 1.66\ Hz}$ (3 marks)

2.b. $s = \frac{3000-2900}{3000} \times 100 = 3.3\%$ (2 marks)

$fr = {}^{sf}/_{100} = {}^{3.3 \times 50}/_{100}$

$\underline{fr = 1.66\ Hz}$ (3 mark)

3. ${}^{V_1}/_{V_2} = {}^{N_1}/_{N_2}$ (1 mark)

$V_2 = V_1.{}^{N_2}/_{N_1}$ (1mark)

$V_2 = 250 \times {}^{400}/_{2000}$ (1 mark)

$\underline{V_2 = 50\,Va.c.}$ (2 mark)

4.a. Star – Delta 3 $\emptyset$ $transformer\ connection.$

(STAR 1) $V_L = 415\,V$

$\therefore V_p = {}^{415}/_{\sqrt{3}} = 240\,V$ $(\boldsymbol{V_1})$ (1 mark)

${}^{V_1}/_{V_2} = {}^{N_1}/_{N_2} = {}^{400}/_{80}$

$V_2 = {}^{V_1 N_2}/_{N_1} = {}^{240 \times 80}/_{400}$ (1 mark)

$V_2 = 48\,Va.c.(= Vp)$ (1 mark)

(DELTA 2) $V_L = V_P$

$= 48Va.c.$

Type equation here.

$delta_2\, \boldsymbol{V_L = V_P = 48V\ a.c}.$ (2 marks)

4.b. Delta - Star 3 $\emptyset$ $trasformer\ connection.$

(DELTA 1) $V_L = V_P = 415\,V(= V_1)$

$\therefore V_2 = {}^{V_1 N_2}/_{N_1} = {}^{415 \times 80}/_{400}$ (1 marks)

$= 83\,V$ (1 marks)

$V_2 = 83\,V\ (= V_p)$ Type equation here. (1 marks)

$(STAR_2\, \boldsymbol{V_L} = \sqrt{\boldsymbol{3V_P}} = \sqrt{\boldsymbol{3}} \times \boldsymbol{83 = 144\ V}$ (2 marks)

5. $I = {}^{V}/_{R}$ Type equation here. (1 mark)

$I_2 = {}^{120}/_{30}$ (1 mark)

$= 4\ Amperes$ (1 marks)

$I_1 = {I_2 V_2}/{V_1}$ (1 mark)

$= 4 \times 120/240$ (1 mark)

$= 2\ Amperes$ (1 marks)

6. What would be the speed of a prime mover driving an alternator which has twelve poles and a frequency of 60 Hz generated.

$freq.\,in\ Hertz = {spd.\,r.\,p.\,m. \times (no.\,of\ \frac{poles}{2})}/{60}$

$n = {120f}/{P}$

$n = {120 \times 60}/{12}$

$n = 600\ r.\,p.\,m.$ (4 marks)

7.a. $n_{syn} = {120f}/{P} = {120 \times 50}/{2} = 3000\ r.\,p.\,m.$ (2 marks)

7.b. $slip\ spd = 3000 - 2850 = 150\ r.\,p.\,m.$ (2 marks)

7.c. $s\% = {n_{syn} - n}/{n_{syn}} \times 100$ (1 mark)

$= {3000 - 2850}/{3000} \times 100$ (1 mark)

$s\% = 5\%$ (2 marks)

7.c. $fr = {sf}/{100} = 5 \times \frac{50}{100} = 2.5\ Hz.$ (2 marks)

END