ASYNCHRONOUS AND DC MACHINES

1. (a) A 4-pole wave-connected armature has 51 slots with 12 conductors per slot. It is known that the number of coils per slot is not 1.
   (i) What are the possible slot arrangements? [2 marks]
   (ii) Find a suitable slot arrangement and draw it. [4 marks]
   (iii) Find the number of coils in the winding. [1 mark]
   (iv) Find the number of turns in a coil. [2 marks]
   (v) Find the coil span y_b in coil sides. [3 marks]
   (vi) How many tours of the armature are required to complete the winding if it is progressive? [2 marks]
   (vii) To which two commutator bars is the coil one connected? [3 marks]

   (b) An 8-pole lap-connected armature has 96 slots with 6 conductors per slot and is driven at 500 rev/min. The useful flux per pole is 0.09 Wb. The number of coils per slot = 3. 12 equalizers are used.

   (i) Calculate the generated emf. [4 marks]
   (ii) Find the commutator bar(s) that must be connected to equalizer number 2 if commutator bar 1 is connected to equalizer number 1. [6 marks]

2. A 6-pole, dc machine has a double layer, lap winding in 63 slots. The coils in the machine have one turn each. There are 189 commutator bars. The flux per pole is 0.082 Wb. The rotor speed is 700 rev/min.
   (a) Find the number of coils per slot. [2 marks]
   (b) Find the number of conductors per slot. [2 marks]
   (c) Is full-pitch winding possible? Why? [2 marks]
   (d) Find the number for the bottom-layer conductor of coil 1. [3 marks]
   (e) We can decide to use equalizers on this machine. Why? [2 marks]
   (f) It is possible to use 21 equalizers on this machine. Why? [2 marks]
   (g) Find the commutator bar(s) to be connected with the commutator bar 1 to an equalizer. [2 marks]
   (h) Find the commutator bar(s) that must be connected to equalizer number 5 if 21 equalizers are used and commutator bar 1 is connected to equalizer number 1. [3 marks]
   (i) Find the dc voltage that is generated in this machine. [5 marks]

3. (a) The armature of a 6-pole d.c. generator has 74 slots, each containing 8 conductors. The machine is required to generate an e.m.f. of 260 V when running at 450 rev/min. The armature winding is wave-connected.
   (i) Find the useful flux per pole. [5 marks]
   (ii) Find the number of turns in a coil if the number of coils per slot is greater than two. [2 marks]
   (iii) Find the total number of coils in the winding. [2 marks]
   (iv) Draw up the winding table for the machine showing only the first row. Consider the winding to be progressive. [11 marks]

   (b) A 4-pole d.c. generator has 264 conductors in 66 slots forming a lap winding with single-turn coils. 11 equalizers are used.
   (i) Find the commutator bar(s) to be connected with the commutator bar 1 to an equalizer. [2 marks]
   (ii) Find the commutator bar(s) that must be connected to equalizer number 2 if commutator bar 1 is connected to equalizer number 1. [3 marks]

4. (a) The armature of a 4-pole d.c. generator has 47 slots, each containing 6 conductors. The armature winding is wave-connected, and the flux per pole is 25 mWb. At what speed must the machine be driven to generate an e.m.f. of 250 V? [6 marks]
   (b) The machine in part (a) has 141 commutator bars or segments.
   (i) Show how the conductors are arranged in a slot. [2 marks]
   (ii) Draw up the winding table for the machine given that the winding is retrogressive. Show only the first *two tours* around the armature. [14 marks]
   (iii) How many tours are required to complete the winding? [1 mark]
   (iv) Is progressive winding also possible? Why? [2 marks]

ANSWERS

1) a) i) 6x2, 2x6, 3x4   ii)3x4   iii)153   iv)2   v)36   vi)77   vii) commutator bars 1&78

    b) i)432V   ii)7,79,151,223

2) a)3

    b)6

    c)No, slot span is not an integer.

    d)31'

    e) Since S/P is an integer.

    f) Because it is less than the maximum and using it will result in the pitch of tapings to be an integer.
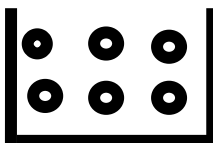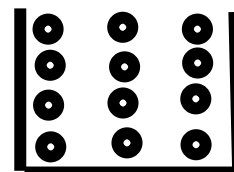
    g)64, 127

    h)13, 76, 139

    i)361.62V

3) a) i)19.5mWb   ii)1   iii)296   iv) y_c=100, y_b=48

Comm bar no__ to	Top layer no____to	Bottom layer no____ to	Comm bar no____
1	1	1+48=49'	1+99=100

    b) i)67   ii)7,73

4) a)1063.83rev/min

    b) i)

Comm bar no__ to	Top layer no____to	Bottom layer no____to	Comm bar no____
1	1	1+33=34'	1+70=71'
71	71	71+33=104'	71+70=141

    iii)70

    iv)Yes, because y_c will still be an integer.

ANSWERS PROVIDED BY
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