Tanta University

Department: Elec. Power and Machines Engineering
Total Marks: 90 Marks

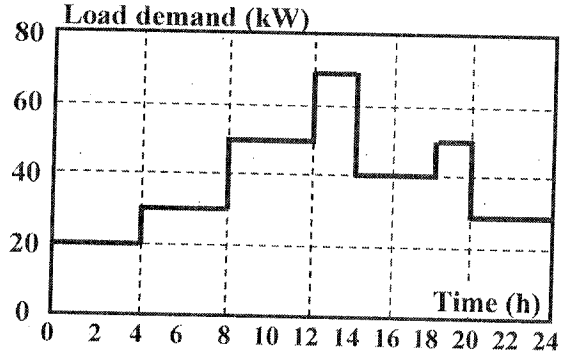
Faculty of Engineering

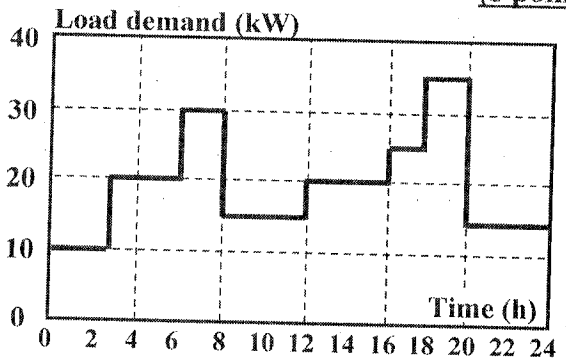
Title: Generation and economy of electrical energy	Course Code: EPM3110	Year: Third year
Date: January 22nd 2022 (First term)	Allowed time: 3 h	No. of Pages: (2)

الامتحان مكون من ٤ أسئلة فى صفحتين

Problem number (1) (25 Marks)

a) Two loads, with the shown daily load curves, are connected to a 150-kW transformer. Find the overall maximum demand, consumed energy, average power, load factor, diversity factor, capacity factor and utilization factor. **(5 points)**





b) Summarize the characteristics and requirements of both the base-load and peak-load generating units. **(5 points)**

c) Spinning reserve cannot be obtained from a single generator. Discuss this fact showing the importance of reserve and the differences between hot and cold reserve. **(5 points)**

d) Classify the costs of power plants giving detailed examples of each type. Discuss how to reduce the overall costs of power plants. **(5 points)**

e) An equipment capital cost is 800000 L.E., with a salvage value of 90000 L.E. A schedule with sinking-value depreciation is used based on a life time of 20 years. After 15 years, the machine is sold for 170000 L.E. If the annual rate of compound interest is 6%, calculate the total accumulated saved money. What would be the extra money paid to buy a new machine for 1200000 L.E if either the sinking-value or straight-line methods were applied? **(5 points)**

Problem number (2) (25 Marks)

a) Recommend a suitable tariff for customers in the following cases. Give reasons for your choice and explain the recommended tariff method: (a) Residential load with high energy consumption, (b) Commercial load low energy consumption, and (c) Industrial load with a compensation capacitor bank. **(3 points)**

b) Discuss the importance of operating constraints in power systems and explain in detail the voltage constraints. **(3 points)**

c) The fuel cost in ($/h) for a power plant with min. and max. power of 20 and 90 MW, respectively, is given by: $F = (20+5*P + 0.05*P^2)$, where P is the generated power in (MW). Calculate the heat rate and plot its curve against the output power. Calculate the incremental fuel cost in $/MWh for a power of 50 MW. **(3 points)**

d) The incremental fuel costs of four generators are given by: $\frac{dF_1}{dP_1} = 0.008P_1 + 5.3$, $\frac{dF_2}{dP_2} = 0.012P_2 + 4.5$, $\frac{dF_3}{dP_3} = 0.014P_3 + 4.2$ and $\frac{dF_4}{dP_4} = 0.02P_4 + 3.8$ all in in ($/MWh). If the total load demand is 800 MW, find the incremental fuel cost of the system and the optimal allocation of load between the units. The minimum and maximum capacities of the first three units are, respectively, 50 and 350 MW. The minimum and maximum capacities of the fourth unit is, respectively, 20 and 150 MW. **(8 points)**

P.T.O.

e) The fuel cost in "$/h" of three different power plants are: $F_1 = 50 + 3.2P_1+0.08P_1^2$, $F_2 =80+5.0P_2+0.08P_2^2$ and $F_3 = 60 + 8\ P_3+ 0.06P_3^2$, where the power is in MW and the power limits are 100 MW and 600 MW. Determine the optimal dispatch and the total cost for a total load demand of 1200 MW. The total power loss is given as: $P_{loss} = 0.015\ P_1^2 + 0.014\ P_1\ P_2 + 0.012\ P_1\ P_3 + 0.012P_2^2 + 0.018\ P_2\ P_3 + 0.012P_3^2$. All quantities are in per unit on a 1000 MVA base. Begin with a lambda value of 60 and penalty factors of unity and use a tolerance of 0.05 p.u. Calculate the optimal annual cost. **(8 points)**

Problem number (3) (20 Marks)

a) Aided with clear sketches, describe the working principles of steam power plants. **What** is the thermal efficiency of such plants and how to improve its value? **(6 points)**

b) State the advantages and disadvantages of nuclear power plants? **(4 points)**

c) Discuss in detail the factors affecting the site selection of solar photovoltaic and onshore wind turbine power plants. **(6 points)**

d) What are the main differences between: **(4 points)**

(i) Diesel and steam power plants. (ii) Nuclear and steam power plants.

(iii) Gas and diesel power plants. (iv) Horizontal-axis and vertical-axis wind turbines.

Problem number (4) (20 Marks)

a) A hydraulic power plant operates at head of 50 m. If the generator efficiency is 85%. What should be the water flow rate to obtain a generated power of 250 MW. Assume that the specific weight of water is 1000 kg/m^3. **(3 points)**

b) With clear schematic diagram, state the definition of hybrid renewable energy systems? In the context of Egypt Vision for sustainable development, **discuss** in detail the advantages of such systems over conventional and single renewable power plants. **(10 points)**

c) **Decide** whether the following statements are correct or false (*correct the false ones*): **(7 points)**

1- Methods of improving thermal efficiency of gas power plants include reheater, regenerator, and condenser.
2- Unlike steam units, the working medium in gas turbines is the product of combustion process and no intermediate fluid is required.
3- The resultant heat energy produced in nuclear power plant reactor is transferred to the coolant.
4- The solar cell delivers the maximum-power point at the point of maximum voltage.
5- Hydraulic power plants have high ramp rate capability and can follow up the load variation.
6- The water flow in hydraulic power plants can be regulated using the surge tank.
7- The faster speed of neutrons, the higher probability that the fission process takes place.
8- Increasing the rated speed of wind turbines decreases the cut-in speed and vice versa.
9- Practical equivalent circuit of photovoltaic solar cells includes a current source in parallel with a diode in addition to a shunt resistance and a series reactance.
10- Give and take process represents performance losses in floating photovoltaic systems.
11- The output power of wind turbine is proportional to the square of wind speed.
12- The material of the electrolyte has to provide a high resistance to protons.
13- Fuel cells cannot be used in cogeneration applications.
14- Despite fuel cells high efficiency, they are not used in large-scale due to their high initial cost.

Good Luck

Course Examination Committee

Prof. Ahmed Refaat Azmy

Tanta University

Department: Computers and Automatic Control
Max Marks: 85 Marks

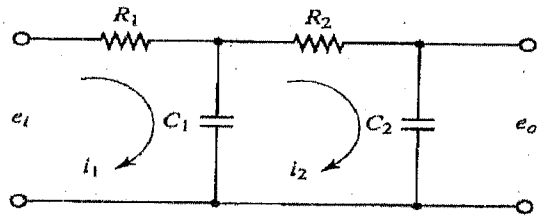
Faculty of Engineering

Course Title: Automatic control Engineering	Year: 3rd	Course Code: CCE3170
Date: 25 /1/ 2022	Allowed time: 3 hrs.	Pages: 2

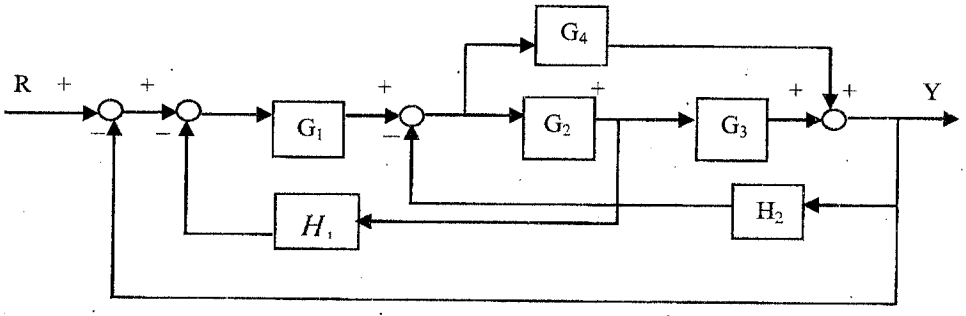
Answer the following 4 questions

Question Number 1: **(25 Points)**

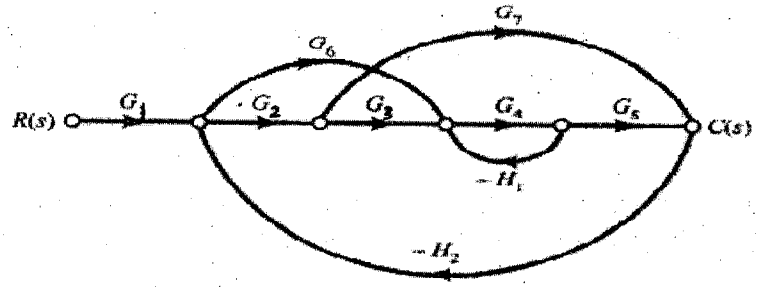
[a] **Find the transfer function for the following circuit E_o/E_i** (7 Points)



[b] **Determine the transfer function using block diagram reduction.** (8 Points)



[c] **Determine the transfer function using signal flow graph.** (10 Points)



Question Number 2: **(20 Points)**

[a] **For each of the following characteristic equations, find the root distribution and determine whether the system is stable, marginally stable, or unstable:** (15 Points)

i) $S^6+S^5+2S^4+2S^3+4S^2+3S+5=0$

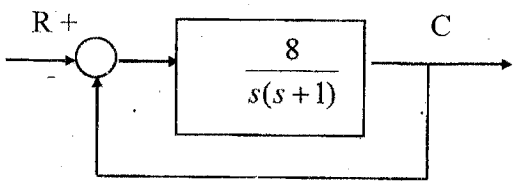
ii) $S^7+S^6+3S^5+S^4+S^3+S^2+3S+1=0$

iii) $s^5+8s^4+2s^3+4s^2+2s+4=0$

iv) $S^6+2S^5+8S^4+15S^3+20S^2+16S+16=0$

v) $S^5+2S^4+3S^2+4S+8=0$

[b] For the following system: (5 Points)



1) Find the type of the system and the order?
2) Determine the natural frequency and damping factor?

Question Number 3: **(22 Points)**

[a] Find a state space model for a control system having the transfer function:

$$G(s) = \frac{8}{(s+2)} \frac{(s+4)}{(s^2+5s+7)}$$

in the pole-zero form (8 Points) and other form (4 Points)

[b] The open loop T.F. of a negative feedback system is given as: (10 Points)

$$G(s)H(s) = \frac{k}{(s-1)(s+5)(s+7)}$$

1) Sketch the root locus.
2) Determine the range of K for system stability
3) Find the value of K at critically damped response

Question Number 4: **(18 Points)**

[a] Given a system described by the dynamic equations

$$\frac{\mathbf{dx(t)}}{\mathbf{dt}} = \mathbf{Ax(t)} + \mathbf{bu(t)} \qquad \mathbf{y(t)} = \mathbf{cx(t)}$$

where

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -7 & -2 \end{bmatrix} \qquad b = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, \text{ and } \quad c = \begin{bmatrix} 1 & 5 & 4 \end{bmatrix}$$

i) Find the characteristic equation. (2 Points)
ii) Find the transfer function Y/U. (2 Points)

[b] For the following system

$$\dot{\underline{X}} = \begin{bmatrix} 0 & 1 \\ -7 & -5 \end{bmatrix} \underline{X} + \begin{bmatrix} 1 \\ 4 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 9 \end{bmatrix} \underline{X}$$

i) Draw the state diagram and Find the transfer function. (4 Points)
ii) Determine whether the system is stable, completely state controllable and observable. (5 Points)

[c] 1- Explain three properties of the system and give an example for each.
2- Define the system order and the state of the system. (5 Points)

The end

Tanta University | Department: Electrical Power and Machines Engineering | Faculty of Engineering

Total Marks: 70 Marks

Course Title: High Voltage Engineering	Course Code: EPM3112	Year: 3rd
Date: 29 Jan. 2022 (First term)	Allowed time: 3 hrs	No. of pages: (3)

Answer all the following questions:

Question (1) **(19Marks)**

a) The following data are obtained while studying the breakdown in a gas:

Gap (mm)	0.75	2.0	2.5	3	3.5	4.0	4.5	5.0	5.5	6
$I\times10^{-14}$ (A)	4	12	18.66	29	45	69.9	109	242	570	890

The minimum current observed is 4×10^{-14} A. Calculate the values of the Townsend's primary and secondary ionization coefficients. **(6 Marks)**

b) The electric field in a non-uniform gas gap is $E = 150e^{-0.5x}$ kV/cm, where x is the distance from the cathode surface in mm. At the cathode surface the first and second ionization coefficients are 0.8 mm^{-1} and 0.02, respectively. If 100 electrons start at the cathode surface, find the number of electrons at a distance of 1.5 mm. The first and second ionization coefficients are in a linear relationship with E and the pressure is constant. **(6 Marks)**

c) Plot the graphical representation of the following: **(3 Marks)**

1. Field Distortion in a Gap due to Space Charge.
2. High frequency breakdown characteristics.
3. Current growth with applied voltage according to Townsend.

d) Choose the correct answer: **(4 Marks)**

1. According to the Paschen's Law, the breakdown voltage of a uniform field gap is
   a. Directly proportional to the gas pressure and inversely proportional to the electrode gap.
   b. Inversely proportional to the gas pressure and directly proportional to the electrode gap.
   c. Directly proportional to the both electrode gap and gas pressure.
   d. Inversely proportional to the both electrode gap and gas pressure.
2. Within dielectric, an electron starting from the cathode will drift towards the anode and during this motion
   a. Gains energy from the field and loses during collision.
   b. Gains energy during both motion and collision.
   c. Loses energy during both motion and collision.
   d. Loses energy from the field and gains during collision.
3. Field in case of rod gaps and sphere gaps are
   a. Uniform, uniform
   b. Uniform, non-uniform
   c. Non-uniform, uniform
   d. Non-uniform, non-uniform
4. Which of the following statements is true regarding corona
   a. Corona takes place at a voltage lower than breakdown voltage
   b. Corona takes place at a voltage higher than breakdown voltage
   c. Corona is a current phenomenon
   d. Corona increases the transmission line efficiency

Question (2) **(18 Marks)**

a) An impulse generator with each condenser rated for 0.12 μF and 130 kV. The load capacitor is 1200 pF and the series resistance is 1000 Ω. Find the number of stages and the damping resistance needed to produce a 3.396/60 μs impulse wave. **(4 Marks)**

b) The input voltage to a 80 kVA, 400 V/150 kV testing transformer is 120 V. The transformer has a resistance and a leakage reactance of 0.01 p.u. and 0.06 p.u respectively, on 80 kVA base. If the charging current of the cable at 60 Hz is 450 mA and the added inductance is 150 H, find the voltage at which the cable is tested. What is the required inductance to be added to minimize the input voltage? What is this voltage? Assume that the testing voltage is maintained as the initial case. . **(6 Marks)**

c) The number of stages of a Cockcroft-Walton type voltage multiplier with 80 nf capacitances is 9 stages. If the voltage regulation at a load current of 8 mA is 8%, calculate the maximum secondary voltage of the supply transformer at a frequency of 100 Hz. Find also the percentage ripple and the optimum number of stages for minimum voltage drop. **(4 Marks)**

d) Choose the correct answer: **(4 Marks)**

1. Van de Graaff generators are useful for
   a. very high voltage and low current applications.
   b. very high voltage and high current applications.
   c. constant high voltage and current applications.
   d. high voltage pulses only.
2. A Tesla coil is a
   a. cascaded transformer.
   b. coreless transformer.
   c. high frequency resonant transformer.
   d. low impedance transformer.
3. Electrostatic voltmeter can measure
   a. DC voltmeter b. AC voltmeter c. Both a and b d. None of these
4. Sphere gaps are used to measure
   a. DC voltage b. AC voltage c. Impulse voltage d. All of these

Question (3) **(15 Marks)**

a) If the applied field to a liquid is given as $E = 2 \times 10^6 X^{1.2}$ V/m and the relative permittivity of the liquid is 2.1, calculate the force acting on an impurity with a relative permittivity of 3.0 and a radius of 20 mm travelling at a distance of 1 cm. **(4Marks)**

b) Plot the graphical representation of the following: **(4 Marks)**

1. The change of solid dielectric thickness against applied voltage.
2. Partial discharge sequence in a cavity into a solid dielectric under AC voltage.
3. Breakdown due to suspended particles in liquid dielectrics.
4. Rate of energy loss from electrons to lattice and energy gain by electrons in solid dielectrics at three different electric fields $E_1 > E_2 > E_3$.

c) A solid dielectric has relative permittivity of 4 and a young's modulus of 160 kg/cm^2. Calculate the highest apparent electric stress before breakdown. **(3Marks)**

d) Choose the correct answer: **(4 Marks)**

1. The increase in liquid hydrostatic pressure
   a. Increases the breakdown strength
   b. Decreases the breakdown strength
   c. Does not affect the breakdown strength
   d. None of these
2. According to the Stressed Oil volume theory, the breakdown strength is
   a. Directly proportional to the stressed oil volume
   b. Directly proportional to the square of the stressed oil volume
   c. Inversely proportional to the stressed oil volume
   d. None of these
3. The thermal breakdown stresses are
   a. Lower under ac conditions than under dc condition
   b. Greater under ac condition than dc condition
   c. Equal in both condition
   d. None of these

4. A good dielectric should have all the following properties EXCEPT
   a. high mechanical strength. b. high resistance to thermal deterioration
   c. high dielectric loss. d. freedom from gaseous inclusions.

Question (4) **(18 Marks)**

a) Choose the correct answer **(5 Marks)**

1. Moisture content in the soil _____ the earth soil resistance.
   a. increase b. decrease c. does not affect
2. Ground resistance should be designed such that
   a. Grounding resistance should be always zero
   b. Grounding resistance should be as low as possible
   c. Grounding resistance should be as high as possible
3. Switching surge is
   a. high voltage ac
   b. short duration transient voltage
   c. hyperbolically dying voltage.
4. For operating power frequency voltages, a surge arrester has to be a
   a. Conductor b. Non-conductor c. Semiconductor
5. Earthing is necessary to give protection against
   a. Danger of electric shock
   b. Voltage fluctuation
   c. Overloading
   d. High temperature of the conductors

b) Derive an expression for an impulse wave. Describe with only equations how to control the rise and tail times of this impulse wave **(4 Marks).**

c) Describe the current-voltage relationship for both Metal-oxide surge arrester and Zinc oxide varistor. **(3 Marks).**

d) A single-phase lossless overhead line with $Z_A = 400\ \Omega$, $\upsilon_A = 3\times10^8$ m/s and $L_A = 30$ km is connected to a single phase lossless cable with $Z_B = 100\ \Omega$, $\upsilon_B = 2\times10^8$ m/s and $L_B = 20$ km. At the sending end of line A, there is a generator with neglected internal impedance. At the receiving end of cable B is a short circuit. Plot the voltage at the line-cable junction versus distance at time of 0.35 ms. **(6 Marks)**

Best wishes:

Dr. Eman Gaber

Tanta University

Department: Engineering Physics and Mathematics

Faculty of Engineering

Course Title: Probability Theory	**Course Code:** PME3114 (3rd electrical power)	**Year:** 2021/2022
Date: 18-1- 2022 (First term)	**Allowed time:** 3 Hrs	**No. of Pages:** (3)

Remarks: Answer All of the Following Questions

Question Number (1):

a) It is known that of the articles produced by a factory, 20% come from Machine A, 30% from Machine B, and 50% from Machine C. The percentages of satisfactory articles among those produced are 95% for A, 85% for B and 90% for C. An article is chosen at random.

I. What is the probability that it is satisfactory?

II. Assuming that the article is satisfactory, what is the probability that it was produced by Machine A?

b) A sample of 30 electrical components was tested by operating each component continuously until it failed. The time to the nearest hour at which each component failed was recorded as follow

31, 41, 46, 33, 44, 51, 56, 63, 71, 71, 62, 63, 54, 53, 51,
43, 36, 38, 54, 56, 66, 71, 74, 75, 46, 47, 59, 60, 61, 63

I. Make a frequency table for this data using open class intervals with width 5.

II. Draw the frequency histogram, frequency polygon and O-give.

III. Find mean, standard deviation, median and mode of the data in the grouped frequency distribution.

c) In a group of 72 students, 14 take neither English nor chemistry, 42 take English and 38 take Chemistry. What is the probability that a student chosen at random from this group takes:

I. both English and Chemistry?

II. Chemistry but not English?

III. English if he didn't take Chemistry?

Question Number (2)

a) Given $f(x) = \begin{cases} \frac{k}{x^2} & 1 \le x < 3 \\ 0 & otherwise \end{cases}$, determine the value of k that will make $f(x)$ a probability density function.

I. Find the cumulative probability distribution function $F(x)$ and use it to determine $P(2 \le X < 3)$.

II. Find the probability that X is exactly equal to 2.

III. Find the mean and standard deviation of this probability distribution.

IV. Find $E[(3X+1)^2]$ and $V(X-2)$.

b) The average zinc concentration recovered from a sample of measurements taken in **36** different locations in a river is found to be **2.6** grams per millilitre. Construct **95% confidence interval** for the mean zinc concentration in the river if the population standard deviation is **0.3** gram per millilitre.

c) The average number of collisions occurring in a week during the summer months at a particular intersection is **2**. Assume that the requirements of the **Poisson distribution** are satisfied.

I. What is the probability of no collisions in any particular week?

II. What is the probability that there will be exactly two collisions in a week?

III. What is the probability of finding more than two collisions in a week?

Question Number (3)

a) A metal rod was gradually heated and its length was measured at various temperatures as follow

Tempreture	15	20	25	30	35	50	70
length	2.1	2.6	2.9	3.3	4	5.1	7

I. Draw the scatter diagram for this data.

II. Compute the linear correlation coefficient r and determine its type.

III. Find the linear prediction equation then estimate rod length at temperature 33.

b) An electric institute published figures on the number of kilowatt hours used annually by various home appliances. It is claimed that a vacuum cleaner uses an average of 46 kilowatt hours per year. Test the hypothesis that $\mu = 46$ kilowatt hours per year against the alternative that $\mu \neq 46$ kilowatt hours per year if a random sample of **12** homes included in a planned study indicates that vacuum cleaners use an average of **42** kilowatt hours per year with a standard deviation of **11.9** kilowatt hours per year. Use a **0.05** level of significance.

c) A city installs **2000** electric lamps for street lighting. These lamps have a mean burning life of **1000** hours with a standard deviation of **200** hours. The normal distribution is a close approximation to this case.

I. What is the probability that a lamp will fail in the first 700 burning hours?

II. How many lamps are expected to fail between 900 and 1300 burning hours?

III. After how many burning hours would we expect 10% of the lamps to be left?

With my best wishes

Course Coordinator ..... **Dr. Eng.** *Eman Elghamry*

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2969	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3513	0.3554	0.3577	0.3529	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

ν \ α	0.1	0.05	0.025	0.01	0.005	0.001	0.0005
1	3.078	6.314	12.076	31.821	63.657	318.310	636.620
2	1.886	2.920	4.303	6.965	9.925	22.326	31.598
3	1.638	2.353	3.182	4.541	5.841	10.213	12.924
4	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	1.319	1.714	2.069	2.500	2.807	3.485	3.767
24	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	1.296	1.671	2.000	2.390	2.660	3.232	3.460
120	1.289	1.658	1.980	2.358	2.617	3.160	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.090	3.291

Tanta University	Department of Electrical Power and Machines Engineering	Faculty of Engineering

Final Exam 2021/2022		
3rd Year: Electrical Power and Machines Engineering	**Time: 3 hours**	**Marks: 120**
Date: January 15, 2022	**Course: Electric Machines (2)**	**Code: EPM3111**

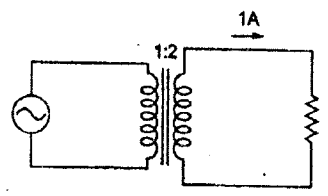
Question one [35 Marks]

A. Choose the correct answer for the following statements. **It is sufficient to write down the question number followed by your choice** in your answer sheet: *[15 Marks]*

1. A single-phase transformer when supplied from 220 V, 50 Hz has eddy current loss of 50 W. If the transformer is connected to a voltage of 330 V, 50 Hz, the eddy current loss will be
   (a) 168.75 W (b) 112.5 W
   (c) 75 W (d) 50 W

2. 1 kVA, 230 V, 50 Hz, single phase transformer has an eddy current loss of 30 watts. The eddy current loss when the transformer is excited by a dc source of same voltage will be
   (a) 30 watts (b) more than 30 watts
   (c) less than 30 watts (d) zero watt

3. A single-phase transformer has a turns ratio of 1:2 and is connected to a purely resistive load as shown in the figure. The magnetizing current drawn is 1 A, and the secondary current is 1 A. If the core losses and the leakage reactance are neglected, the primary current is



   (a) 1.41 A (b) 2 A
   (c) 2.24 A (d) 3 A

4. The mutual flux in a loaded transformer can be varied by varying
   (a) primary current (b) load impedance
   (c) secondary current (d) reluctance of the magnetic path

5. A transformer is supplying pure resistive load. The power factor on primary side will be
   (a) about 0.95 (lead) (b) about 0.95 (lag)
   (c) zero (d) unity

6. In the transformer circuit mode, the core loss is represented as a
   (a) series resistance (b) series inductance
   (c) shunt resistance (d) shunt inductance

7. Zero voltage regulation is an indication of ..... load.
   (a) inductive (b) capacitive
   (c) either inductive or capacitive (d) pure resistive

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8. A shell type transformer is commonly used as it has
   (a) two magnetic paths (b) reduced magnetic flux leakage
   (c) reduce copper losses (d) both (a) and (b)

9. When one transformer is removed from a Δ-Δ bank of 30 kVA transformer, the capacity of the resulting 3-phase transformer in open delta connection will be:
   (a) 11.5 kVA (b) 17.3 kVA
   (c) 20 kVA (d) 25.9 kVA

10. A single phase transformer has rating of 15 kVA, 600/120 V. It is reconnected as an auto-transformer to supply at 720 V from a 600 V primary source. The maximum load it can supply is
   (a) 90 kVA (b) 18 kVA
   (c) 15 kVA (d) 12 kVA

B. State true (√) or false (×) and correct the false statements. **It is sufficient to write down the question number followed by your choice** in your answer sheet: *[20 Marks]*

1) Transformers are classified according to the number of phases into Auto transformer, Two-winding, and Tertiary winding.
2) In step-up transformers, the output current is more than the input current.
3) In shell-type transformers, the windings are put on the outer limb of the core.
4) In core-type transformers, the maintenance is easier and the voltage regulation is better.
5) The two-winding transformer transforms energy from one circuit (primary side) to the other (secondary side) via induction as well as conduction.
6) Three-winding transformer is used for special applications where two same voltage levels are required such as in substations for auxiliary loads.
7) Distribution transformer is used in power plant and grid substations for high voltage step up and step down.
8) The mutual flux is produced in the transformer due to the applied voltage on the primary winding and load current component.
9) The voltage polarity and current directions in a transformer do not depend upon the way in which windings are wound.
10) The eddy current loss in a transformer is minimized by using high-grade magnetic material while the hysteresis loss is minimized by using laminated core.
11) The leakage flux path in the air varies linearly with current.
12) In the equivalent circuit of a practical transformer, the magnetization of the core is modelled using a magnetizing resistance as a shunt branch.
13) The short-circuit test is generally conducted with applying a reduced voltage on the low voltage side.
14) The turn ratio of the ideal transformer affects the magnitudes and angles of the voltages and currents.
15) The maximum efficiency in a transformer occurs when the copper loss is equal to half the core/iron loss and the load is resistive.
16) An autotransformer can safely be used for stepping down higher voltages to much lower voltages suitable for smaller loads.

17) Single unit of three-phase transformer offers greater flexibility in installation.
18) A three-phase transformer constructed from three single-phase transformers, occupies less space, and costs less.
19) The secondary winding of a current transformer should never be left open.
20) The magnetic core of a potential transformer usually has a shell-type construction for better accuracy.

Question Two [50 Marks]

A. **Discuss,** ***with all suitable details and sketches***, the main classifications for a transformer based on the number of windings and construction. ***[5 Marks]***

B. **Explain,** ***with all necessary equations and figures***, the phasor diagram of the two-winding transformer under different load conditions (lag, lead, and unity power factor). **Give** the power factor condition at which the voltage regulation would be minimum. ***[5 Marks]***

C. **Explain,** ***with all necessary equations and figures***, how to reconnect a two-winding transformer as an autotransformer. **What** are the main advantages and disadvantages of an autotransformer? ***[5 Marks]***

D. Given the maximum efficiency of 98.8% for a two-winding transformer at 12 kVA and 0.9 power factor. **Compute** the efficiency at 4.5 kW and 0.85 power factor. ***[15 Marks]***

E. A 1φ, 25 kVA, 2300/230 V transformer has the following parameters: ***[20 Marks]***

$Z_{eq} = 4.0 + j\ 5.0\ \Omega$ (High-voltage side)
$R_c = 450\ \Omega$ (Low-voltage side)
$X_m = 300\ \Omega$ (Low-voltage side)

The transformer is connected to a load whose power factor varies.

i. **Determine** the worst-case voltage regulation for half full-load output and **draw** the phasor diagram.

ii. **Determine** the efficiency when the transformer loading is reduced by 20% of full load at rated voltage and 0.85 power factor lagging.

iii. **Determine** the percentage loading of the transformer at which the efficiency is a maximum and **calculate** this efficiency.

Question Three [35 Marks]

A. Write down the line/phase currents and line/phase voltages for a standard Δ-Δ connected transformer and for an open-delta transformer. How much power can an open-delta deliver compared to a standard three phase delta transformer? What happens to the rest of the open-delta bank's rating? ***[15 Marks]***

B. **Explain**, ***with the aid of equation(s) and figure(s)***, that " the maximum applied voltage (and therefore the rated voltage) is set by the maximum acceptable magnetization current in the core of transformer". ***[10 Marks]***

C. **Explain**, ***with equations and waves***, the problem of current inrush. **Why** switching the primary of the transformer at 0 degree of input voltage is the worst case of inrush current and 90 degrees is the no problem case? ***[10 Marks]***

Good Luck and Best Wishes

Assoc. Prof. Dr. Abdelsalam Ahmed *Dr. Mohamed Gamal Hussien*