CE (Extra).

L4-/T-I/EEE

Date: 17/09/2025

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-I B.Sc. Engineering Examinations 2023-2024

Sub: **EEE 411 (Power System II)**

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

The corresponding Course Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column. The COs of the Course are mentioned at the end of the question paper.

SECTION – A

There are **FOUR** questions in this section. Answer to Question No. 1 is **COMPULSORY**.

Answer any **TWO** questions from Question 2-4.

Symbols and abbreviations have their usual meanings.

1. (a) Discuss various principles for enhancing real transfer capacity of a transmission line staying within its thermal limit. Also name the FACTS device relevant to implementing each of those principles. **(12)** **(CO4)**

(b) A 600 MW wind farm is connected to two transmission regions as shown in Fig. for Q. 1(b). At a given instant the wind farm supplies 200 MW to each region. When the wind farm output increases to 500 MW, it is necessary to send 300 MW to region 1 and 200 MW to region 2. Explain using necessary diagrams how an IPFC could be used to achieve this. Assume the voltage magnitude and angle of the busbars in regions 1 and 2, to which the tie line is connected, are unchanged. **(17)** **(CO4)**

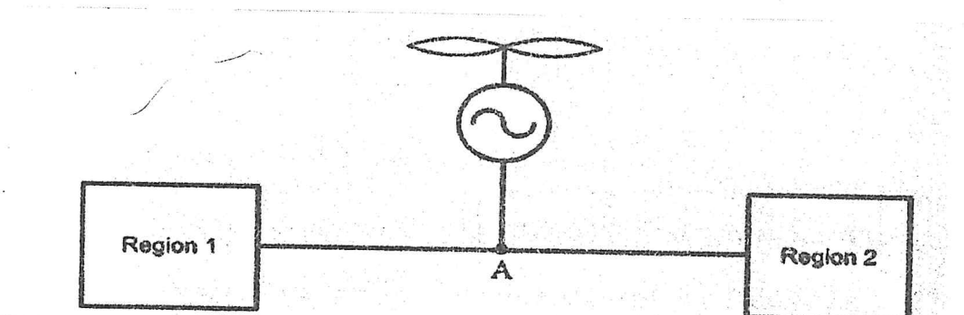

Fig. for Q.1(b)

(c) Mention 4 power quality problems from each of the two categories - transient and sustained. **(6)** **(CO4)**

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2. (a) Draw the models of SSSC, TCSR, TCSC and TSSC. What are the major structural and functional differences among them? **(16)**

(b) What is Sub Synchronous Resonance (SSR)? Which ones of the FACTS devices mentioned in 2(a) may lead to SSR problem? What are the probable remedies to SSR? **(9)**

(c) A series compensated long transmission line connected to a large 50 Hz power system is supplied from a generator. On 100 MVA, 400 kV base generator reactance is 0.1 pu, step up transformer reactance is 0.02 pu and line inductance is 0.04 pu. The mechanical natural frequency of oscillation of the generator-turbine shaft is 20 Hz. Calculate the value of the series capacitor and degree of compensation in % which will result in SSR. Suggest a safer degree of compensation in % which will simultaneously avoid SSR, improve voltage regulation and enhance power transfer capability for the given system. **(10)**

3. (a) What are the major sources of power quality problems? **(6)**

b) i)Explain flicker curve, threshold of visibility and threshold of irritation. **(6)**

ii) Distinguish between instantaneous, short term and long term flicker indices. **(6)**

iii) Mention the correlation between flicker curves and values of flicker indices. **(4)**

c) Discuss the supply and demand side remedies to flicker using diagrams where applicable. **(13)**

4. (a) Explain the reasons for grounding in power system. **(18)**

b)Why in a given system or subsystem only one neutral to ground is permitted? **(7)**

c) Suppose a consumer wants to connect an arcing load at a location on a 132 kV feeder where short circuit current is 17 kA. The load has a continuous rated current of 1000 amps and a TDD of 4 %. Should the utility allow this load? If yes why? If not what needs to be done? The current distortion percentage limits allowed by IEEE Standard 519 for 132 kV system is shown in the Table below. **(10)**

Table for Q. 4(c)

I_{sc}/I_L	TDD
$< 20^c$	2.5
20 < 50	4.0
50 < 100	6.0
100 < 1000	7.5
> 1000	10.0

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SECTION – B

There are **FOUR** questions in this section. Answer to Question No. 5 is **COMPULSORY**.

Answer any **TWO** questions from Questions 6-8.

Symbols have their usual meanings.

5. (a) A 50 Hz generator having H = 6 MJ/MVA is delivering power of 1.0 per unit to an infinite bus through a purely reactive network when the occurrence of a fault reduces the generator output power to zero. The maximum power that could be delivered is 2.5 per unit. When the fault is cleared using a circuit breaker, the original network conditions again exist. Now, suppose that you have the following information of three relays (R1, R2 and R3): **(12)** **(CO3)**

Relay No	Activation Time	Cost
R1	6 Cycles	100 $
R2	10 Cycles	75 $
R3	15 Cycles	50 $

You have to choose one of these three relays to operate your circuit breaker. Give logical reasons behind your answers from both security and economic perspective.

(b) Explain the classical economic dispatch process of thermal power plants with transmission losses. **(14)** **(CO2)**

(c) Briefly explain i) Frequency Stability, ii) Rotor Angle Stability, and iii) Voltage Stability **(9)** **(CO1)**

6. (a) A 50 Hz generator is supplying 60% of maximum power to an infinite bus through a reactive network. A fault occurs which increases the reactance of the network between the generator internal voltage and the infinite bus by 300%. When the fault is cleared, the maximum power that can be delivered is 80% of the original maximum value. Determine the critical clearing angle for the condition described. If the generator has an inertia constant of 4 MJ/MVA, show the calculations up to 0.2 s to prepare the swing curve. Consider, Δt = 0.05 s, fault clearing time = 0.15 s and the prefault supplied power as 1 per unit. **(25)**

(b) Derive the condition for economic distribution of load between two units within a Power plant. What are the differences between OPF-based dispatching and B-coefficient-based dispatching? **(10)**

7. (a) Derive the swing equation for two non-coherent machines in a power system. **(10)**

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Contd... Q. No. 7

(b) The single line diagram in the following figure shows a generator connected through a parallel transmission line to an infinite bus. The machine is delivering 0.9 per unit power and both the terminal voltage and infinite bus voltage are 1.0 per unit. Determine the power angle equation for the given system operating condition. Also find the initial rotor angle. **(15)**

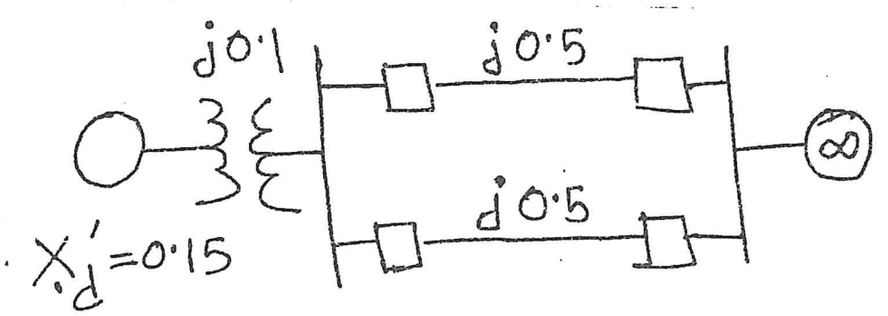

Fig. for Q. 7 (b)

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(c) Derive the expression of the Synchronizing Power Coefficient. Explain its significance in rotor angle stability. **(10)**

8. (a) The generating units at two different power plants have incremental fuel costs in dollar per megawatt hour given by, **(30)**

$$\frac{df_1}{dP_{g1}} = 0.008\,P_{g1} + 8$$

$$\frac{df_2}{dP_{g2}} = 0.0096\,P_{g1} + 6.4$$

At the specified load level of 500 MW, the loss coefficient in per unit on a 100 MVA base is given by,

$$\begin{bmatrix} B_{11} & B_{12} & B_{10}/2 \\ B_{21} & B_{22} & B_{20/2} \\ B_{10}/2 & B_{20}/2 & B_{00} \end{bmatrix} = \begin{bmatrix} 8.38 & -0.049 & 0.375 \\ -0.049 & 5.96 & 0.195 \\ 0.375 & 0.195 & 0.0901 \end{bmatrix} \times 10^{-3}$$

i) Find the initial estimate of the incremental fuel cost (λ) of the plant.

ii) Calculate transmission line loss from the given B coefficients.

iii) What is the value of λ after first iteration?

iv) Find the penalty factors of two power plants.

v) Calculate the incremental fuel costs in $/MWh.

(b) Briefly define steady-state and transient stability of a power system. **(5)**

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Course Outcomes of EEE 411

CO No.	CO Statement
1	**Explain** the transient stability, voltage stability and frequency stability by **applying** the knowledge of power system and rotor dynamics.
2	**Analyse** the techniques economic operation of power system with and without transmission loss.
3	At the end of the course the students will be able to **design** a stability cogitated power system by satisfying necessary requirements
4	At the end of the course the students will be able to **investigate** the techniques for voltage improvement, power system augmentation and power quality improvement.
