FINAL EXAMINATION

SEMESTER II, SESSION 2022/2023

COURSE CODE	:	SEAA 2032
COURSE	:	ELECTRICAL AND MECHANICAL SYSTEM
PROGRAMME	:	SKAW
DURATION	:	2 HOURS
DATE	:	

INSTRUCTION TO CANDIDATES:

1. ANSWER ALL QUESTIONS OF PART A AND PART B IN SEPARATE ANSWER BOOKLETS

2. PLEASE SHOW NEAT CALCULATIONS AND DRAWING ACCORDINGLY

WARNING!

Students caught copying/cheating during the examination will be liable for disciplinary actions and the faculty may recommend the student to be expelled from the study.

This examination question consists of (7) printed pages only.

PART A – ELECTRICAL SYSTEM

Q1. (a) Define the concept of a three-phase system in an electrical system

(3 marks)

(b) In a balanced three-phase Y- Y system, $V_{RY} = 240\angle 40°\ V$ rms. The load impedance per phase is $Z_L = 50 + j\ 40\ \Omega$. Assume a positive sequence.

(i) Draw the above three-phase system and label the line and phase voltages and line and phase currents at the load side

(6 marks)

(ii) Find the line and phase voltage at the load side

(6 marks)

(iii) Find the line and phase current at the load side

(4 marks)

(iv) Calculate the active power, reactive power, and apparent power delivered to the load. Determine also the power factor of the system.

(6 marks)

(25 marks)

Q2. (a) A single-phase stepped-down transformer rating 50 kVA, 11 kV/400 V, 50 Hz. The following is the data from the transformer nameplate.

Resistance of turns at 11 kV	0.5 Ω
Resistance of turn at 400 V	0.05 Ω
Core loss	110 W
Copper loss	10.0 kW

(i) Explain the difference between core loss and copper loss.

(4 marks)

(ii) If the power factor is 0.8, estimate the efficiency (*h*) at full load.

(9 marks)

(b) A 4-pole induction motor is fed with a 230 V, 50 Hz supply and is running multiple loads with a 0.9 power factor. The output power is 4000 W, the copper loss is 150 W, the core loss is 50 W and the rotational loss is 75 W.

(i) Calculate the angular speed in rpm.

(3 marks)

(ii) Estimate the minimum rotor speed if the slip is set to 2.5%.

(6 marks)

(iii) Define the efficiency of the motor.

(3 marks)

(25 marks)

PART B – MECHANICAL SYSTEM

Q1. (a) Describe the terms listed below.

(i) Refrigerant

(2 marks)

(ii) Montreal Protocol

(2 marks)

(iii) Variable refrigerant volume (VAV) system

(2 marks)

(iv) Relative humidity

(2 marks)

(v) Radiation

(2 marks)

(b) Consider a 0.8-m-high and 1.5-m-wide double-pane window consisting of 4-mm-thick layers of material A (k=0.78 W/m °C) and 10-mm-wide of material B (k=0.026 W/m °C). For Fig. Q1 (b) below, determine the steady rate of heat transfer through this double-pane window and the temperature of its inner surface for a day during which the room is maintained at $T_1 = 20°C$ while the temperature outdoors is $T_3 = 10$ °C given that $Q = kA\frac{dT}{dx}$ *and* $R = \frac{L}{kA}$.

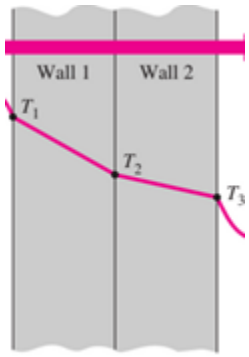


Figure Q1 (b)

(*10 marks*)

Q2. (a) Describe the terms listed below.

(i) Elevator - door interlock

(2 marks)

(ii) Elevator – counterweight

(2 marks)

(iii) Elevator - governor

(2 marks)

(iv) Escalator - safety button

(2 marks)

(v) Escalator – truss

(2 marks)

(b) Design an elevator system for an 11-storey, single-purpose tenant office building that provides a "good" level of service. The following are the requirements for the design.

1. The construction level is "prestige."
2. Floor height: 9' – 6" floor to floor
3. Floor area: 15,500 net square feet (nsf) each

Determine the followings:

(i) Building population
(ii) Rise and minimum car speed
(iii) Average trip time
(iv) Round trip time
5-minute handling capacity (h = 300p/RT)

Show your working procedure in the given table/graphs (refer to appendices on pages 6 and 7) and **submit it** together with the answer script.

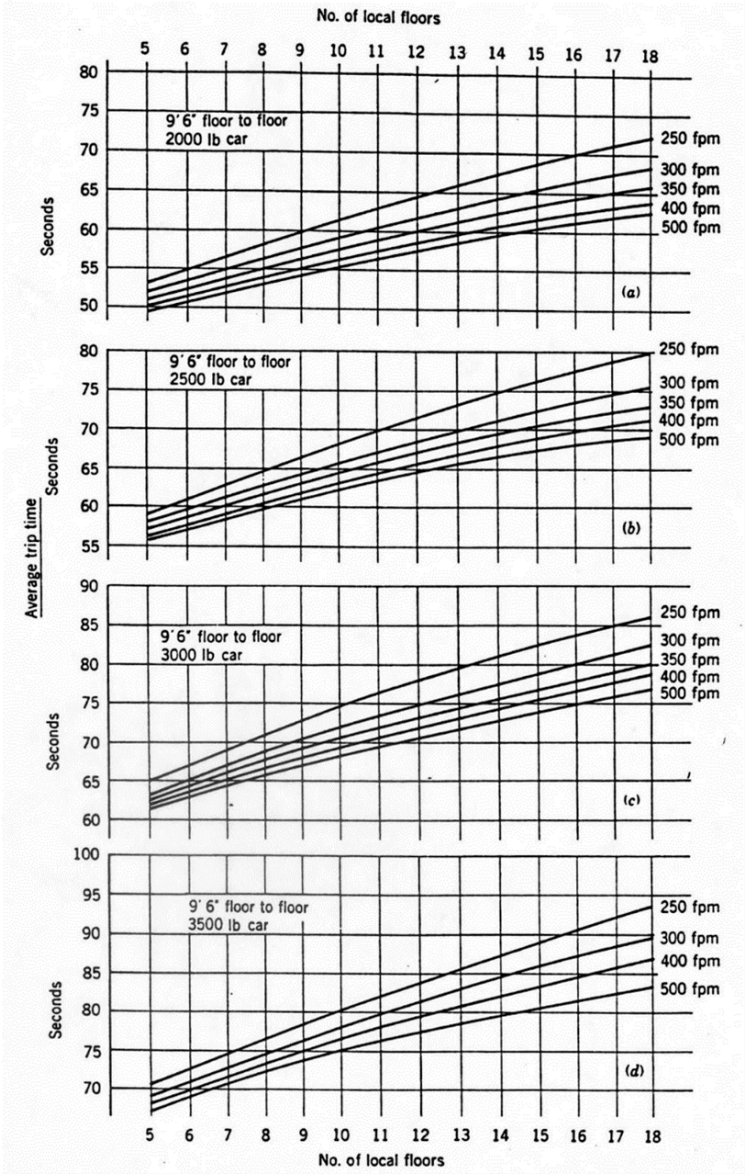
(15 marks)

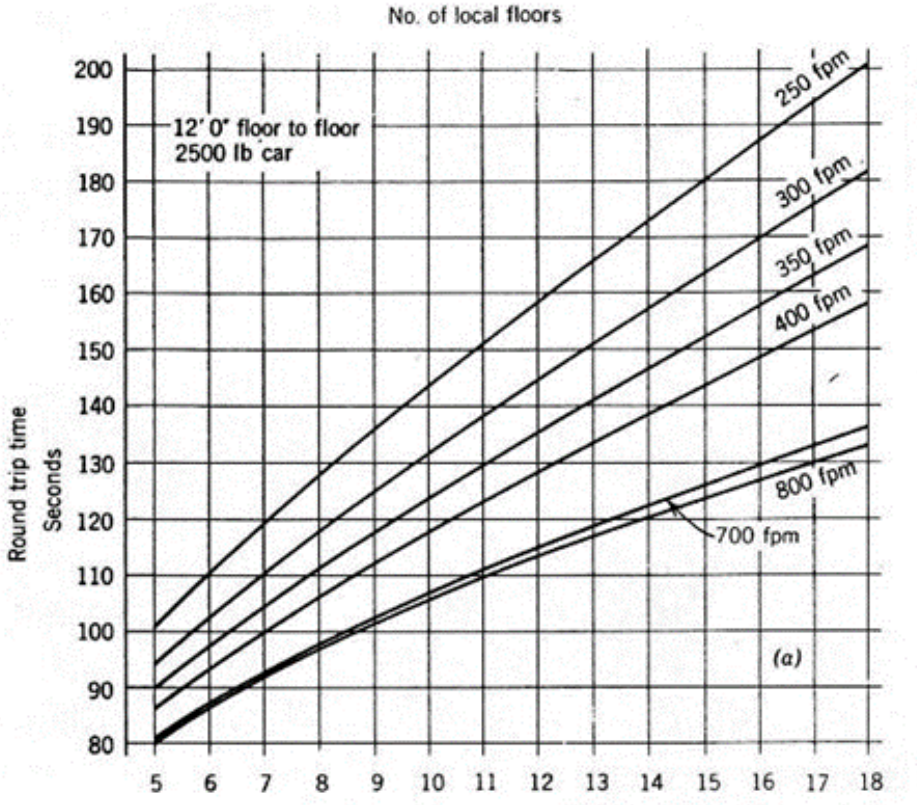
TABLE 23.7 **Population of Typical Buildings for Estimating Elevator and Escalator Requirements**

Building Type	*Net Area*
Office Buildings	*Square feet per person*
Diversified (Multiple Tenancy)	
Normal	110–130[a]
Prestige	150–250
Single Tenancy	
Normal	90–110
Prestige	130–200
Hotels	*Persons per sleeping room*
Normal use	1.3
Conventions	1.9
Hospitals	*Visitors and staff per bed*[b]
General private	3
General public (large wards)	3–4
Apartment Houses	*Persons per bedroom*
High-rental housing	1.5
Moderate-rental housing	2.0
Low-cost housing	2.5–3.0

TABLE 23.9 **Elevator Equipment Recommendations**

Building Type	*Car Capacity*[a] *(lb)*	*Car Capacity*[a] *[kg]*	*Rise (ft)*	*Rise [m]*	*Minimum*[a] *Car Speed (fpm)*	*Minimum*[a] *Car Speed [m/s]*
Office Building	2500	1250	0–125	0–40	350–400	2.0
	3000	1250	126–225	41–70	500–600	2.5
	3500	1600	226–275	71–85	700	3.15
			276–375	86–115	800	4.0
			Above 375	>115	1000	5.0
Hotel	2500	1250	As above		As above	
	3000	1250				
Hospital	3500	1600	0–60	0–20	150	0.63
	4000	2000	61–100	21–30	200–250	1.0
			101–125	31–40	250–300	1.6
			126–175	41–55	350–400	2.0
			176–250	56–75	500–600	3.15
			>250	>75	700	4.0
Apartments	2000	1000	0–75	0–25	100	0.63
	2500	1250	76–125	26–40	200	1.0
			126–200	41–60	250–300	1.6
			>200	>60	350–400	2.0
Stores	3500	1600	0–100	0–30	200	1.0
	4000	2000	101–150	31–45	250–300	1.6
	5000	2500	151–200	46–60	350–400	2.0
			>200	>60	500	2.5


No. of local floors
5 6 7 8 9 10 11 12 13 14 15 16 17 18
Average trip time
Seconds
9'6" floor to floor
2000 lb car
250 fpm
300 fpm
350 fpm
400 fpm
500 fpm
(a)
9'6" floor to floor
2500 lb car
(b)
9'6" floor to floor
3000 lb car
(c)
9'6" floor to floor
3500 lb car
(d)


No. of local floors
Round trip time
Seconds
12'0" floor to floor
2500 lb car
250 fpm
300 fpm
350 fpm
400 fpm
700 fpm
800 fpm
(a)