Formula Sheet for the Final Exam of Unit ENSC2003
(Semester 1, 2021)

Power dissipated by a resistor	P=V*I
Energy	$E = \int_0^{\Delta t} P(t)dt$
Ohm's law	$V = I * R$
Resistors in series connection	$R_{eq} = \sum_{i=1}^{N} R_i = R_1 + R_2 + \cdots + R_N$
Voltage division	$V_i = \frac{R_i}{R_1 + R_2 + \cdots + R_N} V$
Resistors in parallel connection	$\frac{1}{R_{eq}} = \sum_{i=1}^{N} \frac{1}{R_i} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$
Current division	$\frac{i_N}{i} = \frac{1/R_N}{1/R_1 + 1/R_2 + \cdots + 1/R_N}$
Kirchhoff's current law	$\sum_{\substack{n\ at \\ node}} i_n = 0$
Kirchhoff's voltage law	$\sum_{\substack{n,\ around \\ loop}} V_n = 0.$
Source transformations	$v_S = i_S\ R_S$
Current-voltage relationship of Si diode	$i_D = I_S \left(e^{\frac{V_D}{0.025}} - 1 \right)$
Output of Op-Amp	$v_O = A\ (V_+ - V_-),$
Gain of Op-Amp circuits	$A_v = V_{out} / V_{in}$
Unit step-function	$u(t) = \begin{cases} 0, & t < 0 \\ 1, & t \geq 0 \end{cases}$

Current into a capacitor as a result of time varying voltage applied	$i = C\frac{dv}{dt}$
Capacitors in series connection	$\frac{1}{C_T} = \sum_{i=1}^{N}\frac{1}{C_i}$
Capacitors in parallel connection	$C_T = \sum_{i=1}^{N} C_i$
Transient response of a first order RC circuit	$v(t) = V_\infty + (V_0 - V_\infty)e^{-t/\tau}$, where τ =RC
Voltage across an inductor as a result of time varying current applied	$v = L\frac{di}{dt}$
Inductors in series connection	$L_T = \sum_{i=1}^{N} L_i$
Inductors in parallel connection	$\frac{1}{L_T} = \sum_{i=1}^{N}\frac{1}{L_i}$
Transient response of a first order RL circuit	$i(t) = I_\infty + (I_0 - I_\infty)e^{-t/\tau}$, where τ =L/R
Sinusoidal signal	$s(t) = A\cos(\omega t + \phi)$
Complex number in cartesian format $z = x + jy$	Polar form $z = r\angle\theta$ Exponential form $z = re^{i\theta}$, where $r = \sqrt{x^2 + y^2}$, $\theta = tan^{-1}(\frac{y}{x})$
In time domain, $v(t) = V_0 cos(\omega t + \phi)$	In frequency/phasor domain, $\bar{V} = V_0 e^{j\phi}$
Conversion of signa $\bar{V}$ from frequency domain to time domain	$v(t) = Re\{\bar{V}e^{j\omega t}\}$
Impedance and admittance of Resistor	$\bar{Z} = R$; $\bar{Y} = 1/R$
Impedance and admittance of Capacitor	$\bar{Z} = 1/j\omega C$; $\bar{Y} = j\omega C$
Impedance and admittance of Inductor	$\bar{Z} = j\omega L$; $\bar{Y} = 1/j\omega L$
Impedances in series connection	$\bar{Z}_T = \sum_{i=1}^{N}\bar{Z}_i$
Impedances in parallel connection	$\frac{1}{\bar{Z}_T} = \sum_{i=1}^{N}\frac{1}{\bar{Z}_i}$

RMS voltage	$V_{RMS} = \sqrt{\frac{1}{T}\int_{t=0}^{T} v^2(t)dt}$
RMS current	$I_{RMS} = \sqrt{\frac{1}{T}\int_{t=0}^{T} i^2(t)dt}$
Average power	$P_{avg} = \frac{1}{T}\int_{t=0}^{T} P(t)dt$
Average power for sinusoidal signal	$P_{avg} = V_{RMS} I_{RMS} \cos(\phi)$
Complex power ***S***	$\boldsymbol{S} = \bar{V}_{RMS}\, \bar{I}^*_{RMS} = \frac{V\,I}{2}\angle(\theta - \phi) = P + jQ$
Maximum power transfer	$\overline{Z_L} = \overline{Z_S^*}$; $P_{max} = \frac{V_S^2}{4R_S}$
DC motor operation	Electrical side: $v_a - i_a R_a - k_{aP}\omega_m = 0$
	Mechanical side $k_{TP} i_a = T_L + b\omega_m$
Ideal transformer	$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{i_p}{i_s} = \text{n}$
Impedance transformation	$\overline{Z_{in}} = \frac{1}{n^2}\overline{Z_L}$
Axioms and theorems of Boolean algebra — Identity	X + 0 = X X • 1 = X
Axioms and theorems of Boolean algebra — Null	X + 1 = 1 X • 0 = 0
Axioms and theorems of Boolean algebra — Idempotency	X + X = X X • X = X
Axioms and theorems of Boolean algebra — Involution	(X')' = X
Axioms and theorems of Boolean algebra — Complementarity	X + X' = 1 X • X' = 0
Axioms and theorems of Boolean algebra — Commutativity	X + Y = Y + X X • Y = Y • X
Axioms and theorems of Boolean algebra — Associativity	(X + Y) + Z = X + (Y + Z) (X • Y) • Z = X • (Y • Z)

Axioms and theorems of Boolean algebra — Distributivity	X • (Y + Z) = (X • Y) + (X • Z) X + (Y • Z) = (X + Y) • (X + Z)
Axioms and theorems of Boolean algebra — Uniting	X • Y + X • Y’ = X (X + Y) • (X + Y’) = X
Axioms and theorems of Boolean algebra — Absorption	X + X • Y = X X • (X + Y) = X (X + Y’) • Y = X • Y (X • Y’) + Y = X + Y
Axioms and theorems of Boolean algebra — Factoring	(X + Y) • (X’ + Z) = X • Z + X’ • Y X • Y + X’ • Z = (X + Z) • (X’ + Y)
Axioms and theorems of Boolean algebra — Concensus	(X • Y) + (Y • Z) + (X’ • Z) = X • Y + X’ • Z (X + Y) • (Y + Z) • (X’ + Z) = (X + Y) • (X’ + Z)
Axioms and theorems of Boolean algebra — De Morgan’s	(X + Y + ...)’ = X’ • Y’ • ... (X • Y • ...)’ = X’ + Y’ +