NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA SURATHKAL
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
ACADEMIC SESSION August-December 2025 (EVEN)
Course: EE226: Analog Electronic Circuits (3-1-3) 6
Course Instructor: Dr. JORA M. GONDA (S2)
Assignment-1 Weight: 02 %
Date of Announcement: August 2, 2025, 17:00 hours
Submission due by: 23:55 hours, August 3, 2025 on IRIS-Moodle

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1. Consider the derivation of the companion models for inductors and capacitors for transient simulation. Refer to the steps followed for the derivation of the companion model for an inductor in the class (01-08-2025). We started with,

$$v_L(t) = L\boldsymbol{p}i = L\frac{di_L}{dt} \tag{1}$$

and then using k as time index, with equidistant samples spaced Δt s apart, discretised (1), looking forward one step ahead and wrote

$$v_L(k) = \frac{L}{\Delta t}[i_L(k+1) - i_L(k)] \tag{2}$$

and obtained the companion model,

$$i_L(k+1) = i_L(k) + \frac{\Delta t}{L}v_L(k) = i_L(k) + G_L v_L(k), \quad \text{where}, G_L \triangleq \frac{\Delta t}{L}\,\text{S}. \tag{3}$$

which may also be written as,

$$i_L(k) = i_L(k-1) + G_L v_L(k-1)$$

Now, (3) suggests that an inductor may be replaced by a companion model which is composed of a current source in parallel with a conductance, G_L S. And in this definition (2), the current value of the current in (3) is a sum of the previous value of the current – the history and a current contributed by the product of the conductance equivalent of inductor and the previous value of the integrand (the voltage) across it.

(a) Following a similar procedure obtain the companion model for a capacitor

$$v_C(k+1) = v_C(k) + \ldots. \tag{4}$$

(b) Following a similar procedure and with the definition of differentiation as,

$$v_L(k) = \frac{L}{\Delta t}[i_L(k) - i_L(k-1)] \tag{5}$$

obtain the companion model for an inductor. Compare that with (3)

(c) Following a similar definition as in (5) for capacitor obtain the companion model for a capacitor and compare with that of the (4).

(d) Now take an average of both the models for inductor and capacitor, after adjusting for the matching time indices and obtain the companion models for the inductor and the capacitor – a trapezoidal approximation. The electric circuit simulator SPICE engine employs this approximation for transient analysis. Keep them in your kitty, they will be useful for evaluation.