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18.034 Honors Differential Equations  
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1. (Birkhoff-Rota, #2,3, p. 75) Find a basis of real solutions to the ODE

(a)  $u''' - u,$

(b)  $u^{(IV)} = u.$

2. (Birkhoff-Rota, #2, p.82)

Find a constant coefficient linear operator  $L$  such that  $e^{-t}$ ,  $te^{-t}$ , and  $e^t$  are a basis of solutions for the ODE  $L[u] = 0$ . Then find bases for the second- and third-order ODE  $L^2[u] = 0$  and  $L^3[u] = 0$ .

3. (Birkhoff-Rota, #4, p. 82)

Knowing bases of solutions for  $L_1[u] = 0$  and  $L_2[u] = 0$ , find a basis of solutions for  $(L_1 \circ L_2)[u] = 0$ .

4. (Birkhoff-Rota, #5, p. 82)

Show that every linear differential operator  $L$  with constant *real* coefficients can be factored as  $L = AL_1 \circ L_2 \circ \cdots \circ L_m$  where  $A \in \mathbb{R}$  and  $L_i = D_i + b_i$  or  $L_i = D^2 + p_i D + q_i$ .

5. (Birkhoff-Rota, #8, p. 82)

Prove that  $u'' + 2iu' + 3u = 0$  has no non-trivial real solution.