

**Indian Institute of Technology,  
Kanpur Proposal for a New Course**

1. **Course No:** EE698W (Old Course No)
2. **Course Title:** Analog circuits for signal processing
3. **Per Week Lectures:** 3\_(L), Tutorial:\_(T), Laboratory: (P), Additional Hours[0-2]:\_(A), Credits (3\*L+2\*T+P+A):\_9 **Duration of Course:** Full Semester
4. **Proposing Department/IDP:** EE
5. **Proposing Instructor(s):** R. S. Ashwin Kumar ([ashwinrs@iitk.ac.in](mailto:ashwinrs@iitk.ac.in))  
**Other faculty members interested in teaching the proposed course:**  
Imon Mondal ([imon@iitk.ac.in](mailto:imon@iitk.ac.in)), Chithra ([chithra@iitk.ac.in](mailto:chithra@iitk.ac.in)), Nagarjuna Nallam ([nallam@iitk.ac.in](mailto:nallam@iitk.ac.in))
6. **Course Description:**

**Objectives:** By the end of this course, the students will be able to understand and analyse linear periodically time-varying (LPTV) systems and circuits, get familiarized to circuit theorems pertaining to LPTV networks, periodic-steady-state simulations, noise in LPTV networks, and practically used LPTV circuits, like the N-path filters, N-path mixers, multi-phase dc-dc converters, N-path chopping, etc.,

**Contents (preferably in the form of 5 to 10 broad titles):**

S. No.	Broad Title	Topics	No. of Lectures (1.5 hours each)
1.	LPTV circuits used in voltage regulators	Bandgap reference, basics of linear regulator and switching regulators.	3
2.	Practically useful LPTV circuits using switches & capacitors	Chopping to eliminate flicker noise, variants of switched-RC filter.	3
3.	Basics of linear time invariant and periodically time varying systems	Impulse response for LTI and LPTV systems, Zadeh expansion of LPTV systems, modelling LPTV networks using mixers and LTI systems, notion of harmonic transfer functions (HTF), periodic steady state simulations	3
4.	N-path principle &	Reduce aliasing using N-path principle, N-path LPTV systems examples: multi-phase dc-dc converters, N-path chopping, time-	6

	practical examples	interleaved sampling & ADCs, N-path switched-RC filters, N-path mixers, mixer-first RF receiver.	
5.	Impedance and transfer function representation in LPTV networks	Impedance and admittance conversion matrix, harmonic transfer matrix definitions with practical examples, conversion matrix based analysis of LPTV networks	2
6.	Circuit theorems for LPTV networks	Tellegan's theorem and its extensions, Thevenin & Norton theorem for LPTV networks, reciprocity, inter-reciprocity, adjoint networks	3
7.	Inter-reciprocity in LPTV networks	Understanding inter-reciprocity using conversion matrices, inter-reciprocity relation in time domain, examples	3
8.	Noise in LTI & LPTV networks	Nyquist's noise theorem, Bode's noise theorem, noise in LPTV networks with sampled output, miscellaneous examples.	3
		<b>Total Lectures</b> (1.5 hours each)	26

**A) Pre-requisites:** Consent of the Instructors

**B) Short summary for including in the Courses of Study Booklet:** Linear periodically time varying (LPTV) networks, switched-RC filter, impulse response in LTI & LPTV networks, Zadeh expansion of LPTV networks, Harmonic transfer functions, N-path principle & examples: multi-phase converters, time-interleaved sampling, N-path switched RC filters, N-path mixers, mixer-first RF receiver, circuit theorems for LPTV networks, adjoint LPTV networks, inter-reciprocity in LPTV networks, noise in LTI & LPTV networks with sampled output.

7. **Recommended reference:** There is no single reference for this. It will be based on multiple journal articles that will be shared along with the relevant lectures.

8. **Evaluation Policy:** Assignments: 40%, Mid-sem: 30%, Endsem: 30%.

9. **Course strength last three times:**

**July 2019: 16; July 2020: 9; July 2022: 7**

R. S. Ashwin Kumar

Dated: 14/02/2025

Proposer: R. S. Ashwin Kumar

Dated:

DUGC/DPGC Convener:

**The course is approved / not  
approved**

**Chairman, SUGC/SPGC**

**Dated: \_\_\_\_\_**