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## MANDATORY TASKS

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### Task 1

**In this task, you simulate an incoherent  $M$ ary pulse position modulation (PPM) digital communication system. Assume that the symbol time interval  $T_s$  is divided to  $M$  sub-intervals  $T_s/M$ . In each sub-interval, depending on the transmitted symbol, a random number of electron carriers are detected using photo-detection process. For simplicity, dark current and current thermal noise are assumed negligible.**

- (a) Implement the maximum likelihood decoder structure in MATLAB. Under the Poisson detection condition, plot the output symbol error rate versus average received signal power  $P_s$  for various values of background noise power  $P_n$  and modulation level  $M$ .
- (b) Use Gray coding to assign distinguished bit sequences to the symbols. Assuming Poisson detection condition, calculate the output bit error rate versus average received signal power  $P_s$  for various values of background noise power  $P_n$  and modulation level  $M$ .
- (c) Discuss the impact of the values  $M$ ,  $P_s$ , and  $P_b$  on the bit and symbol error rate performance.
- (d) Compare the obtained simulation results with their corresponding analytical equations. Is there any mismatch between the analytical and simulation results?
- (e) Investigate the asymptotic behavior of the system for  $M \rightarrow \infty$  and  $P_b \rightarrow 0$ .
- (f) Prepare a short report and describe your work concisely. Use suitable figures to better describe the developed codes and to make your report more readable and understandable. Attach a copy of the developed codes to your sent report. Make sure to provide descriptive comments for the simulation codes.

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## BONUS TASKS

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### Task 2

**You can get extra score by doing the optional tasks listed below.**

(a) Extend the simulation setup and obtain the bit and symbol error rates under the Laguerre detection condition with  $D$  received modes. Investigate the impact of  $D$  on the obtained results.

(b) Extend the simulation setup to investigate the impact of the synchronization mismatch on the bit and symbol error rates.

(c) Return your report by filling the  $\LaTeX$  template of the project. If you want to add a figure or a diagram to your report, you can draw it directly using TikZ package, or draw it in a secondary application such as Microsoft Visio and then, import it as a figure. Another option is the website [mathcha](http://mathcha.com), where you can draw a desired diagram and receive its corresponding  $\LaTeX$  code.

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