```
(* Caracterização do tempo de serviço - função característica,
função de distribuição acumulada e função densidade da probabilidade -
 de um canal de uso licenciado com utilização
  baseada em distribuições geométricas. *)

ClearAll["Global`*"]

(* Mean Length Variable*)

pLength = 1 / meanLength;
pON = 1 / meanON;
pOFF = 1 / meanOFF;

fLength := If[k < 1, 0, (1 / meanLength) * (1 - (1 / meanLength)) ^ (k - 1)];
(*DiscretePlot[fLength,{k,1,10}]*)
fON := If[k < 1, 0, (1 / meanON) * (1 - (1 / meanON)) ^ (k - 1)];
(*DiscretePlot[fON,{k,1,10}]*)
fOFF := If[k < 1, 0, (1 / meanOFF) * (1 - (1 / meanOFF)) ^ (k - 1)];
(*DiscretePlot[fOFF,{k,1,10}]*)

fOFF2[r_] =
  If[k ≥ r, Binomial[k - 1, r - 1] * (1 / meanOFF) ^ (r) * (1 - (1 / meanOFF)) ^ (k - r), 0];

diffOFFLength[m_] :=
  Sum[Sum[(fLength /. k → (l)) * fOFF2[r] /. k → (l + n), {l, 1, 100}], {n, m, 300}] -
   Sum[Sum[(fLength /. k → (l)) * fOFF2[r - 1] /. k → (l + n), {l, 1, 100}],
    {n, m, 300}];
DiscretePlot[diffOFFLength[0], {r, 1, 10}];
Sum[N[diffOFFLength[0]], {r, 1, 10}];
Sum[N[diffOFFLength[0] * r], {r, 1, 10}];
Table[N[diffOFFLength[0]], {r, 1, 10}];

PhiTMGF = ((pLength * Exp[z]) / (1 - (1 - pLength) * Exp[z])) *
   ((pON * Exp[z]) / (1 - (1 - pON) * Exp[z])) ^ (kk);

PhiTCF = ((pLength * Exp[ⅈ * z]) / (1 - (1 - pLength) * Exp[ⅈ * z])) *
   ((pON * Exp[ⅈ * z]) / (1 - (1 - pON) * Exp[ⅈ * z])) ^ (kk);



meanLength = 3;
meanON = 1;
meanOFF = 9;
PQE = 1 - 1;
StartOff =
  (1 - PQE) * ((meanOFF - 1) / meanOFF) + PQE * (meanOFF / (meanOFF + meanON));

media =
 N[StartOff * Sum[diffOFFLength[0] * ⅈ^ (-1) * D[PhiTCF /. {kk → (r - 1)}, {z, 1}] /.
      z → 0, {r, 1, 10}] + (1 - StartOff) * Sum[diffOFFLength[0] *
       ⅈ^ (-1) * D[PhiTCF /. {kk → (r)}, {z, 1}] /. z → 0, {r, 1, 10}]]

var2 = N[StartOff * Sum[diffOFFLength[0] * ⅈ^ (-2) *
       D[Exp[-media * ⅈ * z] * PhiTCF /. {kk → (r - 1)}, {z, 2}] /. z → 0, {r, 1, 5}] +
   (1 - StartOff) * Sum[diffOFFLength[0] * ⅈ^ (-2) *
       D[Exp[-media * ⅈ * z] * PhiTCF /. {kk → (r)}, {z, 2}] /. z → 0, {r, 1, 5}]]
```

```
meanLength = 3;
meanON = 1;
meanOFF = 9;
lambda =
  List[1 / 32, 1 / 16.5, 1 / 11, 1 / 8.4, 1 / 6.7, 1 / 5.5, 1 / 4.75, 1 / 4.15, 1 / 3.7];
(*MeanQueueLength=List[0.1152,0.2531,0.4294,0.6304,
   0.9520,1.4871,2.2643,4.1521,9.0662];*)

For[i = 1, i ≤ 9, i++,

 Clear[StartOff, PhiTPond, PPQueue, Sol1, mu, PQE, VarMu];

 Ro = lambda[[i]] / (1 / mu);

 StartOff = (1 - PQE) * ((meanOFF - 1) / meanOFF) + PQE * (meanOFF / (meanOFF + meanON));

 PhiTPondMGF =
  StartOff * Sum[diffOFFLength[0] * PhiTMGF /. {kk → (r - 1)}, {r, 1, 10}] +
   (1 - StartOff) * Sum[diffOFFLength[0] * PhiTMGF /. {kk → (r)}, {r, 1, 10}];

 PPQueue = ((1 - z) * (1 - Ro) * (PhiTPondMGF /. z → -lambda[[i]] + lambda[[i]] * z)) /
   (-z + (PhiTPondMGF /. z → -lambda[[i]] + lambda[[i]] * z));

 Sol1 = Solve[PQE == (D[PPQueue, {z, 0}] /. z → 0) / (0!) &&
    mu == (N[StartOff * Sum[diffOFFLength[0] * ⅈ^(-1) *
            D[PhiTCF /. {kk → (r - 1)}, {z, 1}] /. z → 0, {r, 1, 10}] + (1 - StartOff) *
          Sum[diffOFFLength[0] * ⅈ^(-1) * D[PhiTCF /. {kk → (r)}, {z, 1}] /. z → 0,
           {r, 1, 10}]]) && 1 ≥ PQE ≥ 0 && mu > 0, {PQE, mu}];

 VarMu = N[StartOff * Sum[diffOFFLength[0] * ⅈ^(-2) *
        D[Exp[-mu * ⅈ * z] * PhiTCF /. {kk → (r - 1)}, {z, 2}] /. z → 0, {r, 1, 10}] +
    (1 - StartOff) * Sum[diffOFFLength[0] * ⅈ^(-2) *
        D[Exp[-mu * ⅈ * z] * PhiTCF /. {kk → (r)}, {z, 2}] /. z → 0, {r, 1, 10}]];

 mu = mu /. Sol1[[1]];
 PQE = PQE /. Sol1[[1]];

 (*MeanQueueLength=Sum[k*(D[PPQueue,{z,k}]/.z→0)/(k!),{k,1,20}]
     W=Ro*mu+MeanQueueLength[[i]]*mu;*)

 W = (lambda[[i]] * (VarMu + mu^2)) / (2 - 2 * Ro);
 Q = lambda[[i]] * (W + mu);

 Print[Q];
 Print[W];
 Print[mu];
]
```